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MAY, 1961

ADHESIVES AGE

MANUFACTURE, APPLICATION, TECHNOLOGY, RESEARCH AND MARKETING

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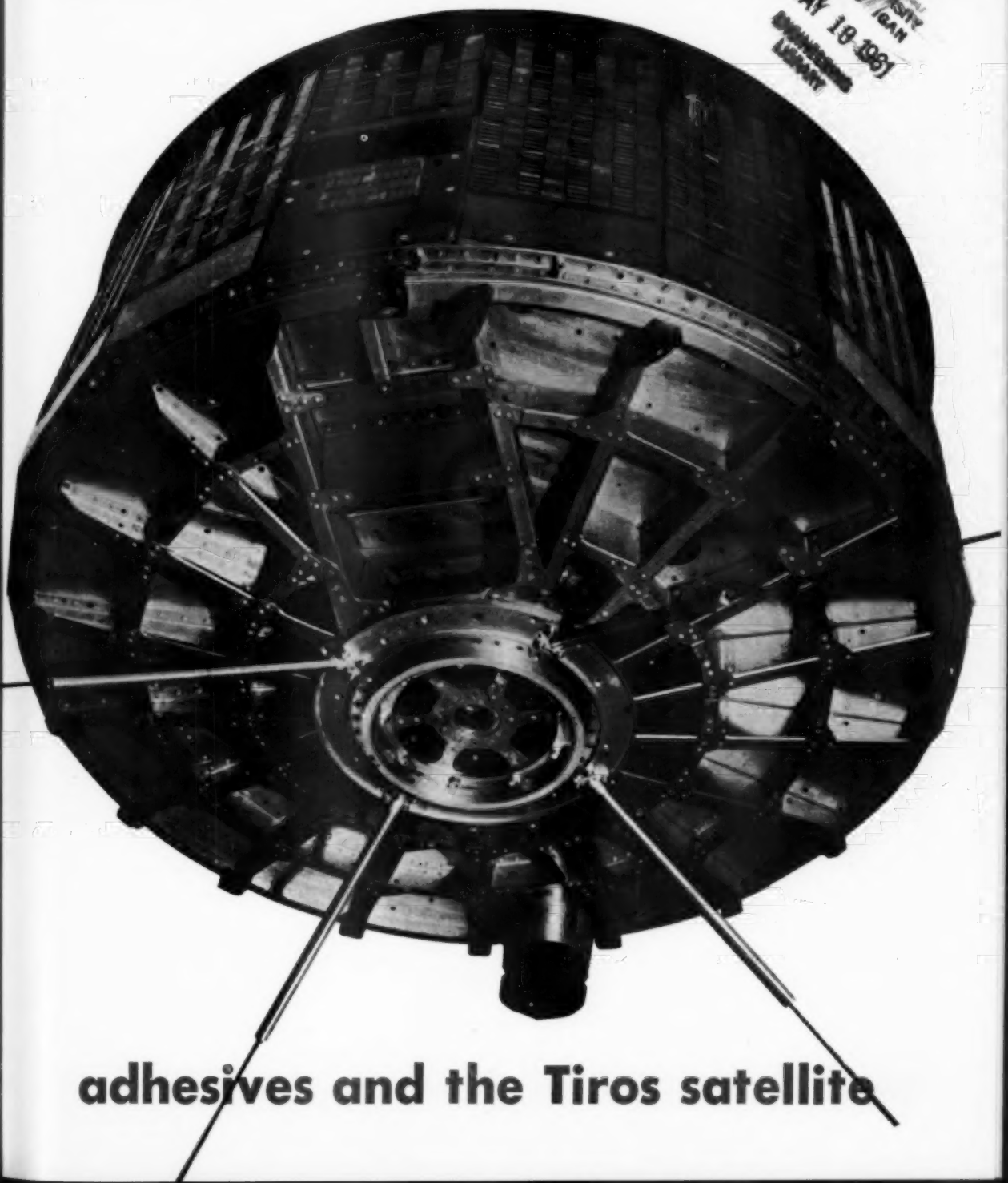

adhesives and the Tiros satellite

Schenectady Phenolic Resins Increase Adhesion, Improve Aging of

Curtain Wall Adhesives

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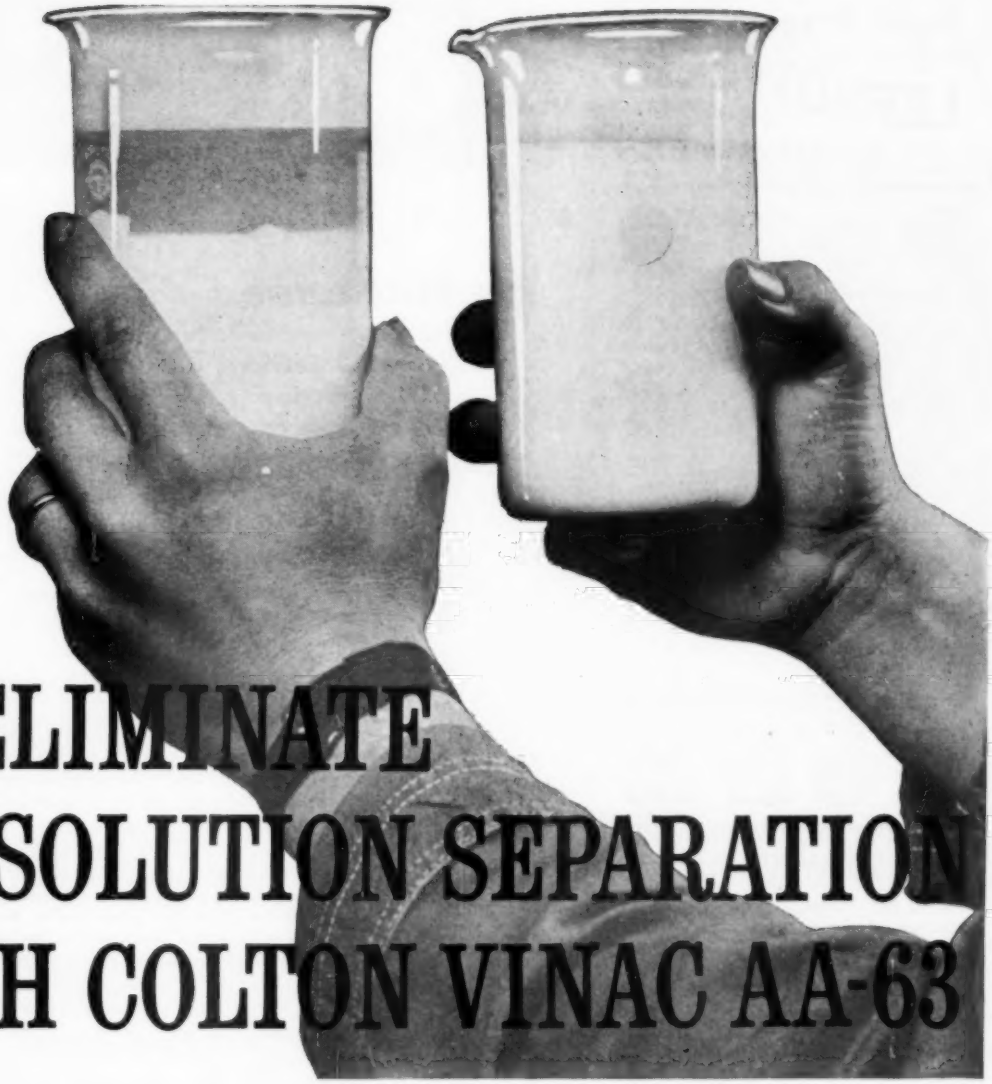

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This new non-creaming polyvinyl-acetate emulsion for adhesives compounding is compatible with solutions of fully hydrolyzed PVA

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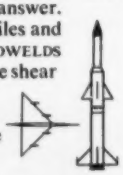

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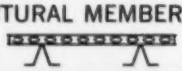

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aa ADHESIVES AGE

In This Issue

How Blood Adhesives Are Used—By L. B. Lane and J. J. Frendreis

One of the oldest adhesives known to man has been averaging an annual gross sales of $4,000,000 in the United States alone 20

Bonded Wire Whiskers Propel Electric Mouse

Solventless adhesive provides a quick-setting bond for sandwiched tines that pulsate at 10,000 movements per minute on electric cable threader 24

Adhesive Bonding Manifold Assemblies

Manifold manufacturer cuts production costs by approximately 50 per cent when he switches from conventional fastening techniques to use of a structural film adhesive 25

A Chemically Welded House

Bonded together from the roof to the base pad, a new satellite-shaped, modern structure was recently launched in Hollywood Hills, California 26

Epoxies for the Tiros Satellite—By Dudley P. Jones

Shingles of 9300 solar cells carried on each satellite unit are mounted by means of a modified epoxy resin structural adhesive formulation 28

About the Cover Photograph

The National Aeronautics and Space Administration's Tiros satellite launched on this month's cover is protected against the hazards of space flight by epoxy resin formulations serving as adhesives, coatings, sealants and encapsulations. Full details on how these resins are being used in this pioneer weather observation project are given in the article starting on page 28.

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PALMERTON PUBLISHING COMPANY, INC.

MAY, 1961

VOL. 4, NO. 5

The Effect of Relative Humidity on the Drying of Adhesives—By George L. Barlow

From all indications, penetration is the primary mechanism that accounts for the development of a fiber tear with aqueous adhesives on paper and paperboard 30

Epoxy Coating Helps Reduce Highway Maintenance

Bridges on New Jersey's Garden State Parkway are protected by epoxy-embedded grit coating that also makes for safer driving 39

An Architect Looks at Bonding Agents for Interior Surfaces—By John H. Graham

Considerable economic advantage may be obtained by taking into account modern bonding agents when planning the construction of new buildings 40

In Future Issues

Adhesive Resin Quality Control

Good quality control can meet many of the problems of the growing profit squeeze

Fabrication Variables and Metal-to-Metal Bonding

Bonding properties can be influenced by the surface conditions of adherends, air entrapment in liquid adhesives, the use of primers, and the amount of pressure used during cure of the assembly

Adhesives for the Future of the Wood Industry

Some of the factors that will influence future adhesive developments in the wood industry

DEPARTMENTS

Book Reviews	62	Names in the News	56
Capitol Cues	15	New Adhesives	10
Classified Advertisements	65	New Equipment	60
Coming Events	54	News of the Industry	42
Consultant's Corner	8	Noted in Passing	66
Editorial	7	On the Continent	18
Patent Review	58		

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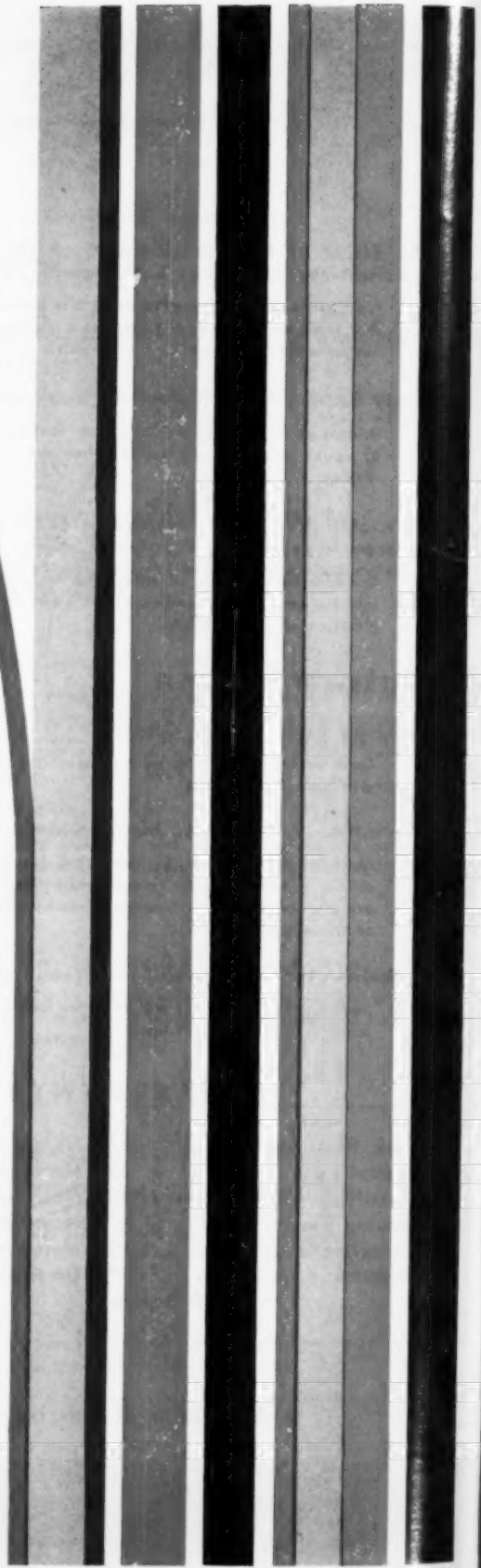

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EDITORIAL

and the road ahead

As a famed humorist used to say, "I only know what I read in the papers." Well, what have we been reading in the papers lately?

Item: Next fall a 35-story office building will start rising in downtown Los Angeles. It won't contain any structural steel.

Item: Producers of basic building materials such as glass, plastics, aluminum, steel, concrete and lumber are in increasingly fierce rivalry.

Item: The use of plastics in construction has risen from 683 million pounds in 1957 to 1.1 billion pounds a year today.

Item: "Sandwich" panel construction is arousing growing interest among home builders.

Item: The $375 million curtain wall market is now the scene of important competition between steel and aluminum producers.

Item: Assembly line production of house components is supplanting on-site manual labor.

Item: Pre-stressed concrete is challenging steel on many new fronts in bridge construction and in office buildings.

The file of clippings grows. "Curtain wall" and "sandwich panel" have entered into our daily vocabulary. Prefabrication not only means less expensive—it means superior. It also means something else. It means adhesives.

Even the most hide-bound among us now recognizes that new building techniques pose an opportunity. An opportunity for the adhesives manufacturer. An opportunity for the adhesives supplier.

Adhesives people, of course, do not necessarily have any part in the competitive struggles between various types of building materials. Adhesives people, on the other hand, must learn how to live with these different materials. Adhesives people should be in a position to cooperate with steel people, with aluminum people, with plastics people, with glass people, with wood people. Moreover, adhesives people should be prepared to do their part in educating lay people that adhesive bonded products will do a job—not as well as mechanical fastening methods—but better than mechanical bonding methods.

The revolution in building techniques brings with it not only the opportunity for larger markets, it brings with it a challenge. Buildings are a major market for adhesives. Building may be the major market for adhesives. We can't sit around to see what basic construction material will come out on top—steel or aluminum, wood or plastics. Our technology and our products have to be equal to whatever demands are placed upon them. Only in this way will we be able to take full advantage of the many opportunities for expanding markets which are now presenting themselves.

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CONSULTANT'S CORNER

By Dr. Irving Skeist

Particle Board Laminate

Question: We have been unsuccessful in locating a procedure for laminating birch and maple veneer to flake board in a three-ply panel. Results to date have been latent surface checking not apparent while panels are dead stacked. Thus far we have reduced glue extension to 25 per cent wheat flour and we have redried faces prior to laminating without success. Any suggestions will be appreciated.

Answer: Your trouble seems to be coming from a telescoping of the flake board — a tendency for it to unmold slightly upon standing. Particle boards are made by compressing flakes, splinters, etc. with the aid of a rather small amount of binder, usually approximately seven per cent of urea formaldehyde resin. The board manufacturer could avoid the trouble by using a greater resin percentage, or perhaps by switching to phenolic resin, but both of these solutions would be expensive.

The cheapest alternative, probably, is to use a highly impregnated, phenolic "B stage" paper between the flake board and the veneer. This paper will deter the flake particles from bulging. In the laminating process, the phenolic impregnated paper bonds to the veneer as well as the particle board, itself becoming cured to the "C stage."

As might be expected in a young and growing

Dr. Skeist is associated with Skeist Laboratories, Inc., 89 Lincoln Park, Newark 2, N.J. He is the author of a study entitled "Epoxy Resins."

Readers who would like to contribute their own experience with problems similar to those discussed in Dr. Skeist's column are invited to write to "Adhesives Age," 101 West 31st Street, New York 1, New York. Please refer to the code number given at the end of each question and answer group.

industry, there are a variety of technical problems associated with the use of particle board. These are being overcome, and we can look forward to continually larger volume applications in furniture, underlayment for vinyl flooring, etc. Particle board uses 50 per cent or so of the wood which cannot be used for lumber. Our timber resources are precious, and particle board helps us to conserve them.

Q-186

Fiberglass-Reinforced Plastic

Question: Can you suggest a combination adhesive-sealant for a structure made of phenolic-glass or polyester-glass sheet.

Specifications for the cured adhesive are: negligible toxicity, flexibility (peel strength), minimum degradation of bond with aging in service, maximum retention of elastic properties (stability of elastic modulus), and service conditions equivalent to immersion in water.

Answer: An epoxy-polyamide blend should be tried for this application.

Q-188

Binder for Sandpaper

Question: We intend to manufacture sandpaper for wood and steel and would like to know what adhesive we can use for this purpose. What would you reccommend for a water-resistant and waterproof binder in sandpaper?

Answer: Animal glue, insolubilized with formaldehyde may be satisfactory. If better water resistance is required, try compounding the glue with urea formaldehyde resin.

Q-187

Wax Candles

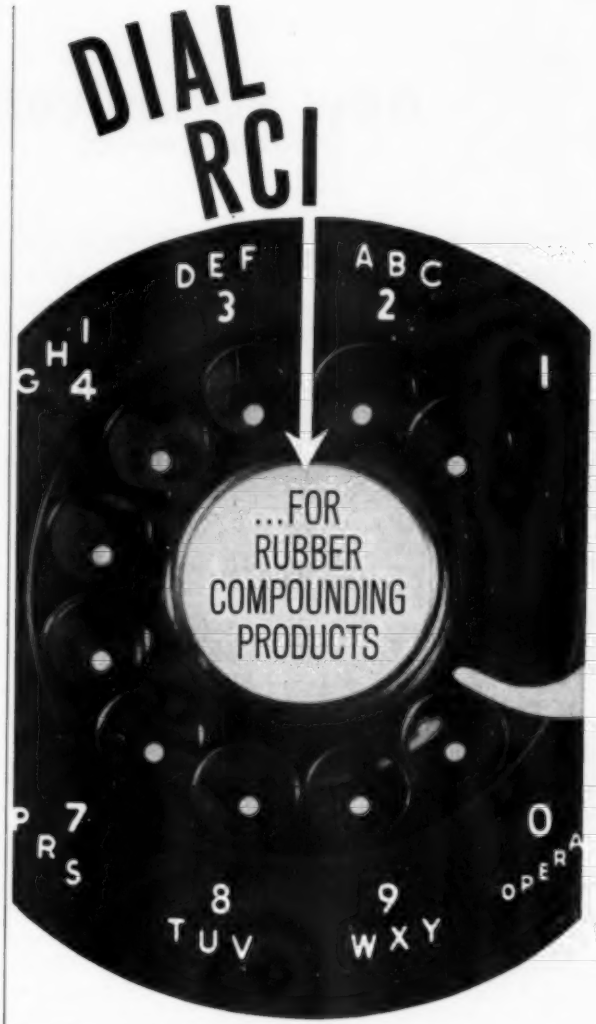
Question: I am doing some candle designing and need an adhesive that will stick wax to wax. The Germans have candles to which wax reliefs are applied with adhesives. The basis of the candle wax is refined paraffin. Stearic acid is added to enable the candles to withstand higher heat.

Answer: Microcrystalline waxes, available from many petroleum companies, are excellent adhesives for paraffin wax.

Q-180

In Our Following Issue

In the June issue of "Adhesives Age," Dr. Sheist will have as his guest columnist Dr. Arthur Hirsch, former technical director for General Gummed Products. Dr. Hirsch will discuss methods for taking the curl out of label stock and gummed paper.



ESTER GUMS All Types. Glycerine and pentaerythritol esters of gum, wood, polymerized wood, hydrogenated wood, dimerized wood and tall oil rosins.

PURE PHENOLIC RESINS Heat Reactive, Novolac Type, Thermoplastic and Terpene. A wide variety of resins intended primarily for tackifying and reinforcing neoprene, acrylonitrile and other synthetic elastomers.

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new adhesives
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Envelope Adhesive

Jet Patch, a special window envelope adhesive for new high speed equipment, permits a manufacturer to increase production by running equipment at top speeds. Another important feature of the new adhesive is its resistance to humidity conditions. According to the manufacturer, it does not distort in low humidity, does not wrinkle or pucker in high humidity and gives a tearing bond at higher humidity than any glassine gum available. The manufacturer states that Jet Patch is easier to handle and cleaner machining. It does not body-up, become stringy or excessively tacky on aging in the drum, or under continued, or interrupted operation.

Jet Patch gives a better margin of safety on aniline inked and other tough to adhere stocks. Its tack, machining, and speed properties make Jet Patch a versatile adhesive that will find use as a standard back gum as well as a glassine gum on both conventional wide-range equipment and new high speed equipment. *National Starch and Chemical Corporation.* **P-486**

Synthetic Sealants

A new line of synthetic rubber sealants under the brand name, Ad-Seal, is available in a non-sag type in gray, black, tan and aluminum and in a pourable type in gray, black and tan. These two-part compounds, when mixed, become thixotropic pastes which cure until they become firm, flexible, synthetic rubbers which are not tacky. They are said to be excellent adhesives as well as sealants and are ideal for many applications such as metal windows, curtain walls, porcelainized metal panels and tilt-up panels. They are used for contraction, expansion and control joints in reservoirs, swimming pools and many types of structures. *Adhesive Engineering.* **P-487**

Carton Sealing Tape

A new carton sealing tape with a quick grip permits extra speed in packaging and packing. The new tape is known as Mystik Brand No. 6376. It has a pressure-sensitive adhesive with a strong affinity for the

cellulose fibers in shipping cartons. The result is exceptionally quick tack and high holding power. No. 6376 was designed to meet the requirements of Government Specification PPP-T-76 for overseas shipment. It has a strong paper backing reinforced with rope fibers that provide high tensile strength under both wet and dry conditions. No. 6376 is especially adapted for sealing fiberboard containers which must withstand rough handling and resist both weather and wear. *Mystik Adhesive Products, Inc.* **P-488**

Color Tinted Labels

An entirely new line of color-tinted, pressure sensitive tabulating labels for use with data processing machines are pastel colored, which provides complete identification for designating plant sites, departmentalizing items, specifying inventory control, allocating seasonal distribution, facilitating filing systems and countless other uses. Each label is of a light pastel color coated stock to permit a clear contrast from imprints. In addition to the three conventional pin feed labels which are available in marginally-punched rolls or fan folded, the company will produce color-tinted labels to specifications. *Pee Cee Tape & Label Co.* **P-489**

Bottle Label Glues

Two new members to the Therma-Tite line of bottle label adhesives, Therma-Tite Bottle Label Adhesives 25-673 and 25-2247, provide instant tack to prevent accidental shifting. However, setting time is delayed to eliminate the tearing of labels on transfer from the applicator and to allow subsequent positioning on the bottles if necessary. The adhesives are delivered with the proper viscosity, ready-for-use.

Therma-Tite 25-673 was developed especially for labeling drug and cosmetic bottles on automatic and semi-automatic bottle labeling machines. It will perform effectively on bottles with light stearate or silicone coatings. The product, easily pumped to the machine, does not body excessively on extended agitation. A heavier viscosity is available for pneumatic scale. Therma-Tite 25-673 offers excellent bonding strength and good flexibility. Its tack qualities are suitable for high-speed labeling. It maintains a satisfactory bond after exposure to both 90 per cent and 10 per cent relative humidities for 72 hours.

Therma-Tite bottle label adhesive 25-2247, a fast-tacking adhesive, was developed for labeling wine, syrup, cordial, salad dressing, condiment, and other bottles that are subjected to damp storage conditions in ice boxes and refrigerators. The adhesive will effectively label warm, moist bottles of catsup, chili sauce, processed cheese, and other products that arrive directly from hot retorts. The adhesive is also engineered to withstand high humidities and refrigeration.

Because it remains in fluid condition, Therma-Tite 25-2247 may be left exposed in the machine without special care. Highly versatile, it will handle a wide variety of labels and bottle shapes. The adhesive also offers the following advantages: (1) non-stringing; (2) excellent tack with a thin film; (3) proper drying throughout a wide range of bottle temperatures; (4) complete absence of crystallization; (5) strong bond regardless of climatic changes; and (6) non-staining, so that bottles are always neat and clean. *Morningstar-Paisley, Inc.* **P-490**

ADHESIVES GUIDE

by JOYCE HURD

• A Practical Handbook

designed to serve as a guide to the types of adhesives available for bonding various materials in various applications. This new British publication covers adhesives used in woodworking, bookbinding, footwear, etc., and offers valuable data on the advantages of adhesive bonding and the classification of adhesives.

Topics Covered

Choice of Adhesives for Various Materials.

Encyclopedia of Basic Adhesive Types.

Classification of Manufacturers (British) by Basic Types of Adhesives Made

Catalog of Adhesive Manufacturers and Their Products

Trade Name Index (British)

Miscellaneous Adhesive Recipes

British Organizations Concerned With Adhesives

Bibliography

With contents including data on something like 400 individual adhesives made by about 100 different manufacturers, this publication will prove to be a valuable edition to your technical library. More than 50 main types of adhesives and their properties are covered.

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Thermosetting Film Adhesive

A new structural thermosetting film adhesive with unique curing properties for metal-to-metal bonding and metal honeycomb sandwich construction, designated as AF-110, can be used for low pressure bonding, requiring only enough pressure during the curing operation to provide contact between the parts being bonded and to keep them properly aligned. This advantage eliminates the need for elaborate or expensive jigs and fixtures for pressure application and makes the adhesive applicable to production bonding operations. This adhesive exceeds the requirements of military specification MIL-A-5090D, Type I for metal-to-metal bonding and MIL-A-25463, Type I, Class 2, for honeycomb sandwich construction. The adhesive provides metal-to-metal shear strengths in excess of 4000 psi at 75°F. service temperature. It has good lay up and conformability characteristics to provide easy application. When properly cured, AF-110 has excellent resistance to vibration, shock and to exposure from water, oils, fuels and salt spray. *Minnesota Mining & Mfg. Company.* **P-491**

Epoxy Adhesive X-305

Adhesive X-305 is a rapid bonding liquid epoxy adhesive suitable for use at room temperature. Setting in 45 seconds, this adhesive immediately provides tensile shear strengths in excess of 2000 psi. The outstanding features built into this unique adhesive system are its nonflammability, low exotherm (250°F. max.), lack of fuming on setting, and easy to use non-critical mixing ratio (by either weight or volume). The sensible mixing ratio easily lends itself to hand cementing techniques and also the use of dual spray gun or mixing/metering equipment. Adhesive X-305 is recommended in applications requiring quick setting adhesives such as repairs to printed circuits, fastening and sealing of electronic components and other devices, replacing soft soldering or welding of jewelry, stone setting, laminating, etc. *Mereco Products.* **P-492**

Silicone Rubber Tape

ES 5215, a new silicone rubber tape made of 2 mil glass cloth with 3 mils of unvulcanized silicone rubber calendered on one side, possesses

high tensile strength. When vulcanized, the product bonds to a homogeneous mass possessing excellent electrical properties and moisture resistance. ES 5215 can be easily handled and applied and is used as a heater element blanket; for wire and motor coil wrapping; ducting and other electrical applications requiring a strong, thin, abrasion- and moisture-resistant wrap. *Permacel.* **P-493**

Transparent Colored Tapes

New transparent, self-sticking colored tapes have been developed and now may be ordered in twenty solid colors and ten unique patterns. These tapes are available in ten standard widths ranging from 1/32 inch to 1 inch. These new tapes are especially designed and manufactured for use in the preparation of artwork, slides, transparencies, etc. When overlayed on maps, drawings, layouts, and graphs, they serve to introduce sections of dramatic color without obscuring any pertinent detail. Their write-on, non-reflecting surface makes them the perfect tool. They are equipped with a non-oozing adhesive which guarantees perfect reproduction. The new transparent tapes in color will save many man hours for the engineer, artist, draftsman, and others in vital jobs in industry and visual aids. *ACS Tapes, Inc.* **P-494**

Neoprene Contact Adhesive

A new general purpose neoprene contact adhesive for bonding a wide variety of materials, gives bonds that have high peel strength, remain permanently strong and resilient, and have good water resistance. The new adhesive, called D-239, was designed for bonding supported vinyl fabrics to metal, wood and composition bases; thin gauge metals or foils to wood, cement asbestos board, hard board and composition bases; and the new fabric backed urethane sheets, such as Armstrong PO-663, to metal, wood and composition bases. D-239 adhesive is a yellow air-drying solvent adhesive with a synthetic rubber base. It has a consistency of thin syrup and may be applied by brush, spray or roller coater. It has good resistance to fatigue or "dead load" and has excellent aging properties. The adhesive is available in one-half pint cans, 48 to the carton; one pint cans, one quart cans, one gallon cans, five gallon pails and 55 gallon drums. *Armstrong Cork Co.* **P-495**

Contact Cement

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- **Vinyl Resins—Mayo Smith. $5.75.** Surveys applications of vinyl resins with information on their types, properties, chemistry, manufacture and fabrication. Includes information on several types of adhesives in this category. ☐

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capitol cues

THE BUSINESS RECOVERY MAY BE A LOT BRISKER than you have been led to believe. Some leading economists in government and industry think they detect signs of a powerful economic expansion--a much sharper upswing than generally projected. These men are still in the minority. But, because of their prestige and influence, their views are worth considering in planning.

> The prevailing view of the business outlook sees an increase of, say, 3% or 4% in total output of goods and services by the end of this year. By contrast, the more optimistic size-up projects a gain of up to 7%--something more akin to the explosive upturn of 1958--during the last business cycle.

YOU CAN MAKE A FAIRLY STRONG CASE FOR A BRISK UPTURN. For one thing, the budget deficits for this and the coming fiscal year may well exceed the President's estimates; this could generate jobs and add to consumer incomes. For another thing, prospects for autos and appliances seem to be improving. The optimists also cite the record of past cycles to prove that recessions usually are followed by quite sharp bouncebacks--not slow, gradual climbs.

> The optimists put a lot of emphasis on a psychological factor --the stock market. They see it as a key force for expansion. The averages may be going up for technical reasons--the shift from bonds by pension trusts, insurance companies, etc. But it does induce consumers and businessmen to raise spending.

KENNEDY'S ADVISERS ARE STILL DISTURBED about the trend--even though business will probably end 1961 with tidy gains. Even if the recovery turns out to be brisk, the stepped-up activity will barely be sufficient to absorb the 1-million-plus new workers to be entering the labor force during 1961. In other words, we'll end '61 with unemployment almost as high as it is now.

> Unemployment is now critical. And officials fear it may get worse unless the economy grows faster. These days, rising productivity can account for the growth we're getting, while very few of the 1 million-plus new workers entering the labor force each year are hired. Economists of the New Frontier feel it will take heavy federal action to get things moving.

THE KENNEDY ADMINISTRATION DOES PLAN ON MORE SPENDING...but in 1962. By that time, officials hope, the political climate will be more favorable. Specifically, they are hoping that Congress will be much more amenable to the President's leadership. Or at least the opposition will be diminished.

> Kennedy's team is counting on two factors to budge Congress:
> -<u>The President's popularity</u>--Polls show that it's very high. Lawmakers hesitate to oppose a President with broad support.
> -<u>Congressmen's own mail</u>--Legislators say that it is now much heavier than normal--and that a preponderance seems to favor the programs that the Kennedy Administration has proposed.
> In 1962, Kennedy people figure, the tide will be with them.

capitol cues (cont'd)

DON'T EXPECT INTEREST RATES TO DECLINE FURTHER in the period ahead, despite the government's steady drive to bring them down as a business spur. The fact that business has begun to head up foreshadows an increased demand for money...to carry inventories, finance consumer buying, and for mortgages. And the Treasury will be borrowing all along to pay for the coming deficits.

> Investment bankers report increasing interest on the part of corporations in floating bond issues to raise funds to meet anticipated needs. Municipalities are already borrowing at a heavy rate. So businessmen are advised not to wait too long before arranging financing. The best time to borrow is now.

DEMANDS FOR GREATER PROTECTION AGAINST IMPORTS are flooding in upon Congress these days. Legislators report that this seems to be one of the hottest issues with the public--union people as well as businessmen. The complaints come from all segments of industry...textiles, machinery, and a wide range of consumer items. Some steps to meet this demand may be taken.

> The Kennedy Administration, like its predecessor, is wedded to a policy of increasingly free trade. Recent actions--on textiles, for example--re-emphasize this. What's more, U.S. negotiators are preparing to grant new tariff cuts during this year's conferences at Geneva. The negotiators already have the powers they need under legislation passed last year. There won't be any opportunity to force increases in duties.
>
> This doesn't mean that there won't be any relief for hard-hit industries. Representation to Congress and the White House, plus threats of boycotts of foreign goods, will bring action to forestall damage to trade relations with friendly nations. The relief, though, will probably take the form of new quotas voluntarily imposed by other countries to limit shipments.

THE GOLD CRISIS MAY NOT BE COMPLETELY OVER YET, say monetary experts. President Kennedy's actions, plus cooperation from countries of West Europe, have bolstered confidence in the dollar and stopped the dangerous outflow. But the threat of a resumption of trouble still persists, below the surface. It could flare up again if budget deficits rekindle inflation later in 1961.

> Rising prices, it is feared, could make American goods less competitive in world markets and, thus, worsen our balance of payments. This, in turn, could feed on itself--damage confidence once again and start gold fleeing to "safer" parts of the world. The chances of avoiding new monetary trouble are seen as little more than, say, three or four to one.

NIXON'S POLITICAL STRATEGY FOR 1964 does not call for running for governor of California next year. Republican political strategists know that he can have the nomination if he wants it; his following is large. But Nixon would be taking a big risk, running against popular Pat Brown.

> If Nixon lost next year, his chances for 1964 would be hurt. So he's expected to play it safe--unless Rockefeller's star begins rising so fast that a vote-getting show is necessary.

• **German Edition of Dow Publication.** *Plastirama*, the house organ of the Dow Chemical International Limited S.A., is also published in German. The same heavy coated paper, the same excellent halftones, the same very enlightening feature articles and the same instructive and well documented descriptions of new products, make up the contents of the German edition. It is with a feeling of great satisfaction that one reads the attractive booklet which will inform the German speaking part of the world about the latest progress in America. We are impressed with this excellent presentation of American accomplishments. The list of representatives and foreign offices of Dow Organization, filling almost an entire page, makes it easy to contact the respective sales outlets in almost any part of the world. However, a little more care in translating the English copy, rather than transcribing it, would be suggested. For example, the first aid kit should rightfully be called in German "eine kleine Erste-Hilfe-Schachtel" and not "Hilfe-Kasten." "Kasten" is something large—large enough to hang your clothes in, for example.

• **New Austrian Firm.** Oesterreichische Kunststoffwerke AG (Austrian Plastics Manufacturing Co.) and Semperitt Oesterreichisch-Amerikanische Gummiwerke AG (Semperit Austro-American Rubber Works), have organized a firm for the joint production and sale of plastic foil, plates and floor coverings. The new company, Interplastic-Werke Ag, will have a capital of approximately 2 million dollars. The annual production will amount to approximately 20,000 tons, equal to nearly one-sixth by weight of Austria's current total raw plastics productions. Exports will be strongly promoted; so far about 40 per cent of the total production, 60 per cent of the foil output, has been exported.

In view of the ever increasing demand, despite the assumed upsurge in manufactured plastics exports, Austria will in all likelihood remain a net importer for some time to come.

• **Stepping Stones to the Metric System.** In the course of recent political developments, more and more nations have adopted the metric system. A few weeks ago, South Africa has changed its monetary system of pounds, shillings and pence to decimal coinage and has consequently changed adding machines, computers, gasoline pumps and other business machines in order to cope with the new unit of currency, the rand, worth about $1.40. Like the dollar, the rand is divided into 100 cents. The changeover is still another step to divorce South Africa from British ways and to establish an independent national personality.

Fortunately, we in America have the dollar and its decimal subdivisions; however, if an American were to tell a European that our yearly budget amounts to approximately 80 billion dollars, the European would probably not understand what billion means. It would require lengthy explanations and finally, the European would nod his head and say, "Oh, you mean milliard!" It would seem to be an easy task to remove this discrepancy; when our experts get together the next time with their European counterparts, it might be a good idea to discuss that particular point.

Recently it became known that Cuba has adopted the metric system in order to discard archaic units of measurement, such as quintals and others. Russia introduced the metric system many years ago and has done away with many obsolescent, ambiguous and confusing units of weights, measurements, etc. In order to simplify the contacts between the old and the new nations, more and more people adopt the metric system; how long can we stubbornly cling to the units such as gallon, ton, mile, hundredweight and many others.

• **USSR Production Figures.** Soviet facts and figures are a little different from the boastful claims which can be heard over the international radio waves and read in many newspapers and magazines. According to the official figures of the Central Office of Statistics of the Soviet Union, the following units have been produced during the first six months of 1960: 8.4 million tires; 285 electrical buses; 189,000 trucks and buses; 68,000 automobiles; 119,000 tractors; 269,000 motorcycles and finally for the entire USSR only 1½ million bicycles, although the latter are very easy to manufacture. Highly industrialized Czechoslovakia, which had been built up during the Austro-Hungarian monarchy by creating tremendous industrial combines such as the Skoda Works, has been very feeble in producing trucks, buses and other automotive equipment. Only 14,600 trucks, 1700 buses, 50,500 automobiles and 233,000 motorcycles, mopeds and motor scooters have been shipped in 1959.

The United States produces an average of 100,000 automobiles a week. An analysis of these figures proves that it will take quite some time before Soviet Russia will be able to catch up with us. In the meantime, they have done better than we have in one respect. Strange as it seems, they apparently have much better public relations people than we have.

IN KABUL VERY FEW OVEREAT

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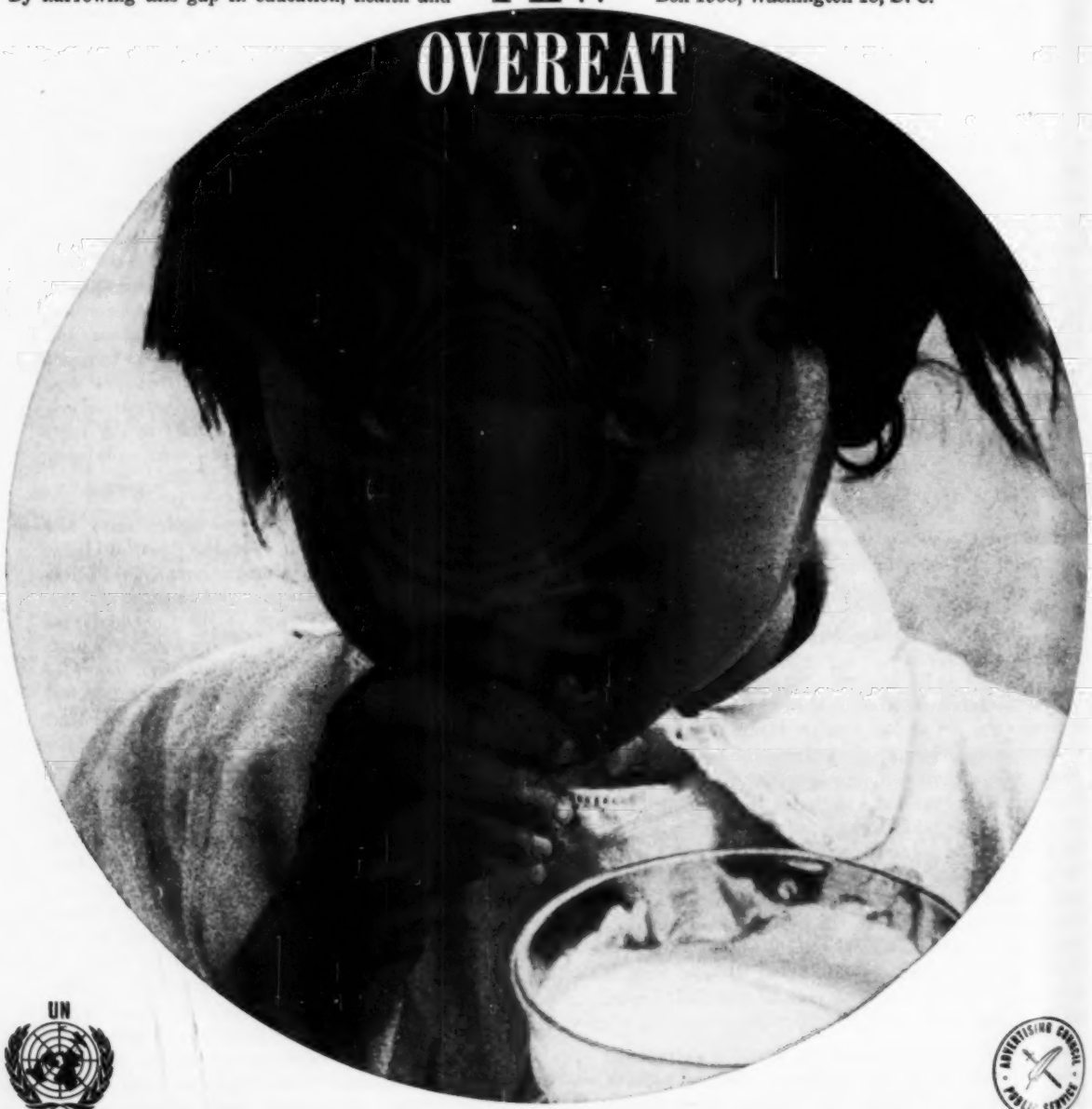

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On the Continent (cont'd)

● **Rails Glued to Roadbed.** The Institute for Railway Construction of the Technical College in Munich, has developed a new method for fastening rails to roadbeds by using a special adhesive. The technique may revolutionize the entire process of railway roadbed construction. No ballast—gravel for the roadbed —and no ties for the rails are used in this process; the rails are directly glued to the concrete which is the basis of the roadbed. Every six yards small adjusters fastened to the roadbed permit slight corrections in the width and the height of the rails. At the present time, the Hamburg elevated railway is experimenting with the new process on a siding. If the experiments prove successful, a test track about 1500 to 1800 feet long will be used for additional experiments.

The new process would be of great importance to the German Railway which plans to electrify large segments of the rail network within the next two or three years. Because of the fact that the road ballast and ties will not be needed when using this process, rails and adjusters will be anchored one and a half feet below the present level, thus eliminating the additional cost of enlarging tunnels and changing superstructures when electrifying the rail network.

● **Polymeric Binders For Non-Woven Textiles.** During the last eight years, our production of non-woven textiles rose from 10 million to 90 million pounds. For 1964 an output of at least 170 million pounds is to be expected, just to meet expansion of present markets. To tie together the fiber employed in making non-woven textiles, various polymeric binders are used. It is estimated that by 1964 approximately 60 million pounds of binders per year will be required.

Emulsion-type binder systems are commercially the most important, being characterized by ease of handling and freedom from the hazards which are associated with organic solvent systems. Among the binders applied in the form of aqueous emulsions are polyvinyl chloride, polymers of acrylate esters, polychloroprene, butadiene-styrene and butadiene-acrylonitrile resins. All of these are thermoplastics, but the commercially less important thermosetting binders may also be applied. Theoretically, it should be possible to use any binder which softens and flows at a temperature below the softening point of the fibers.

An article in *Adhesives & Resins*, a British publication, points out that either thermosetting or thermoplastic resins can serve. Among thermosetting binders, melamine-formaldehyde, methoxylated urea-formaldehyde and ethylene urea-formaldehyde derivatives are the most important. Thermosetting binders are particularly interesting in producing non-woven fabrics of high cellulose content to which they impart greater crease resistance and resilience as well as improved wet strength.

The ideal binder for non-woven textiles is not yet at hand. The chief characteristics which such a system would possess are: high strength, ease of uniform application to the web, high specific adhesion to the fiber, good elasticity and elastic recovery. Finally, and depending on intended field of application, the binder should be light-, wash- and clean-fast, should be free from discoloration and should exhibit good dimensional stability. The web incorporating the binder should have good crease resistance, resilience, softness and, for certain uses, should be heat-sealable.

● **Europlastica.** The International Plastics Exhibit in Ghent (Belgium) will be held from June 16th to 26th, 1961, according to a resolution of all plastics industrial associations of the European Common Market. Incidentally, Copenhagen has arranged for an International Plastics Fair which will be staged from September 22 to October 1, 1961.

● **New Rubber-to-Steel Adhesive.** Two new adhesives have been developed for bonding butyl rubber to steel. They are said to give exceptionally high performance under stringent operating conditions. The new compounds are said by the scientists responsible for developing them to be especially useful in bonding butyl rubber having a low sulphur content to steel.

According to *The Financial Times*, London, such rubbers have low adhesion values and are normally exceptionally difficult to bond to metal effectively. The metal to which the rubber is to be bonded is cleaned by sand-blasting and then dipped in a ten per cent by volume solution of phosphoric acid. It is then washed in hot water and dried and a thin coat of the cement primer is applied. When this is dry, after about five minutes, a second coat is applied and dried. The metal is then ready for the application of the buytl rubber.

● **Curing Rubber Latex.** The Dunlop Rubber Co. Ltd. has just received a patent covering a method for curing rubber latex without the use of heat. The method yields articles having a greater strength than that of articles obtained by prior techniques. The rubber latex is cured in the form of an aqueous dispersion by subjecting it to high energy radiation. The irradiated latex can then be formed into shaped articles by the known methods and allowed to dry. It is quite stable and can be used for the production of cured articles without the addition of sulphur or any other curing or vulcanizing agents.

The high energy radiation can be any form of radiation having an energy greater than about 0.1 mega electron volts. This includes x-rays, gamma rays, accelerated electrons from linear accelerators or similar machines, beta rays, alpha rays, accelerated protons and deutrons, neutrons produced in atomic piles or other sources.

By L. B. LANE and J. J. FRENDREIS
Armour Alliance Industries
Alliance, Ohio

How Blood Adhesives Are Used

In recent years United States industry alone has annually consumed more than 33,000,000 pounds of animal blood for use in adhesive formulations

At a time when industry is striving to develop new and exotic adhesives to meet the ever expanding needs of our industrial economy, it is interesting to observe how one of the oldest adhesives known to man continues to fulfill a surprising variety of industrial needs. The product is blood, specifically animal blood, an unromantic, yet chemically unique and versatile material.

Little data exists relating to the exact time or place when blood was first used for adhesive purposes. It is reported that the blood of Russian slaves was mixed with mortar to form a bridge (located in Tiflis, Caucasus) that has withstood the ravages of weather and floods for more than 1600 years. It is also known that the early Chinese used a mixture of blood and lime as a protective covering for wood, but it is doubtful whether it was used as a glue at that time.

About 1910, reports were circulated in the United States that a water-resistant blood glue had been discovered in Russia, but early attempts to duplicate it met with little success.

In 1913, H. L. Haskell and J. W. Beiger produced the first waterproof albumen glue. Early experiments utilized egg albumen, but later blood albumin, which was cheaper and more readily available, was substituted. To prove their formula, the two developed the first molded plywood canoes produced in this country using soluble dried blood as the adhesive medium.

About 1917, a demand developed for water-resistant plywood for military purposes. Such plywood was used extensively in boats and in American fighter plane construction. Plywood utilizing blood adhesives was also used in planes belonging to Byrd, Chamberlain and perhaps the most famous of all, Col. Charles Lindbergh's "Spirit of St. Louis."

Use As Fortifier

Since World War I, many successful uses have been found for blood in industry. The largest single use by far is in the manufacture of Douglas Fir plywood. Today, blood is used in combination with soy as a fortifying agent in bonding interior grades of plywood. Together they form an economical and effective adhesive that is relatively easy to formulate and to apply. The economical blood-soy combination exhibits many unique features such as proper creep for forming purposes, water-resistance, and the elimination of dulling action on cutting tools. Blood is also used as an extender of phenolic resin adhesives.

An important application during World War II included the use of blood as one component of a "tire dip" developed to obtain a good adhesion between rubber and nylon cord. The formulation was an emulsion comprised, in part at least, of resorcinol formaldehyde resin, SBR latex, blood and water. SBR latex and resorcinol alone or together

About the Authors . . .

LEONARD B. LANE, technical service manager of Armour Alliance Industries, joined the company in 1924. He received his BS in chemical engineering from Purdue University.

JOHN J. FRENDREIS, product sales manager, Industrial Blood Products Dept., Adhesive Div., Armour Alliance joined Armour & Co. in 1925. He is a Northwestern University graduate.

did not produce a strong enough bond, but with from one to two per cent of blood in the latex the strength was about doubled — an amazing discovery back in the '40's. In fact, synthetic latex plus blood equaled the strength property of natural latex (Liberian latex, for instance) which was unavailable. The strength of natural latex has been attributed to the presence of traces of nitrogen in the rubber molecule and, reportedly, the addition of soluble dried blood aided efforts to duplicate the rubber, nitrogen-bearing molecule.

It is estimated that during 1959 alone, the United States consumed about 33,000,000 pounds of animal blood for adhesive purposes with a gross sales value of $4,000,000. Ninety-eight per cent of all blood adhesives produced in the United States is used in the Douglas Fir plywood industry. Other adhesive applications of blood include: particle board, hardboard, bottle crowns, and musical instruments.

Some lesser uses of blood products include: polymerization of rubber compounds, insecticidal binder, settling compound for industrial waste treatment, clear water purification (paper industry), uranium purification, foaming agent for lightweight cellular concrete, fire foaming agent, wine clarifying agent, paper coatings and binders, paper flocculants and sizes, replacement of casein in latex emulsions, emulsified asphalt, cork composition, photoengraving plate-making solutions, leather finishing operations, water-resistant binder of pigments for print dyeing on cotton cloth, and amino acid production such as histidine and histamine, for example.

What They Are

What are blood adhesives? How are they made and used? To answer these questions, one must first know the composition and characteristics, (both physical and chemical) of blood itself.

What is blood? Blood is an aqueous solution in which are suspended red and white corpuscles. Blood is usually classified as a tissue, and differs from the other tissues of the body in that its inter-cellular substance, the blood plasma, is fluid instead of solid.

Red Blood Cells—These are minute biconcave discs which in mammals are non-nucleated, and which contain a protein pigment called hemoglobin.

White Blood Cells—These are fewer in number but larger than red blood cells. They are nucleated and the protoplasm of the cell body is more or less granular.

Plasma—The fluid portion of the blood, called plasma, consists of water containing albumins, globulins, fibrinogen, calcium salts and traces of other substances.

If blood escapes from the body, coagulation occurs; after standing awhile, the blood separates into two portions, namely, a contracting semi-solid mass, the clot, and a thin light amber (or straw-colored) liquid, the serum. The clot thus formed is composed of the red blood corpuscles matted together with the fibrin.

View of the blood adhesive section at Armour Alliance's South St. Paul plant. The vacuum conveying system is upper left. Numbered boxes are used for blending. Part of the evaporator is behind the upper column.

Manufacturers of blood products take advantage of the physical and chemical properties of blood to produce the following materials: dried beef fibrin, blood albumin, dried hemoglobin and soluble dried blood. We will describe most briefly the various manufacturing steps and uses of these individual products in the order listed above.

To the beef blood, caught directly from the animal, anti-coagulant is added to prevent clotting. This is followed by passing the

View of filling unit at St. Paul blood adhesive plant. The bag filler is in the left foreground. Liquid blood tanks and pumps are shown on the right.

At the American Seating Co. classroom furniture is made from plywood using glue fortified by soluble dried blood. A steam-heat press, left, forms the various shapes and thicknesses.

liquor through a centrifuge to separate the blood into two liquid fractions—plasma and hemoglobin.

The plasma consists of serum and fibrinogen. By means of a chemical treatment, followed by stirring, the latter material separates and is screened out in the form of a white fibrous water-insoluble mass known as fibrin. Fibrin is used almost entirely as a pharmaceutical raw material.

The clear light-colored liquor remaining after removal of the fibrin is known as beef blood serum. An appreciable amount of this material, treated with preservative, is used "as is" in leather finishes. However, the bulk of it is spray-dried under carefully controlled conditions so as not to insolubilize the material in process. The resultant material is a light straw-colored fine powder known as blood albumin. Some of its important uses include:

(1) *Cork Industry* — The albumin is used in bottle crown manufacture as an adhesive in bonding the composition cork sliver to the inside of the metal cap.

(2) *Leather Industry* — In this field, the albumin is used in leather finishing operations. In one instance, the albumin supplies the bonding power in leather finishes comprised essentially of pigment (color) and waxes. Such dressings not only impart smoothness and luster to the leather but provide color and water resistance. In another instance, the material is applied in a dilute liquid state to the top side of the leather just prior to burnishing or glazing to produce a smooth finish and high luster.

(3) *Textile Industry* — Albumin serves as a mordant and highly water-resistant binder of pigments in print dyeing of cotton cloth. Its presence permits repeated laundering of these prints without noticeable loss of color.

The hemoglobin is sold in the dry state principally to the pharmaceutical industry as a raw material for the manufacture of histidine, a well-known amino acid. It also is an excellent emulsifying agent.

Defibrinated beef blood is supplied to the tanning industry for leather finishing.

Soluble dried blood is produced essentially from a combination of

Physical and Chemical Characteristics of Blood Products

	Soluble Blood	*Blood Albumin*	*Dried Fibrin*
Origin (Raw Material)	Dried Defibrinated Animal Blood	Beef Serum	Beef Fibrin
Form	Powder	Powder	Lumpy
Color	Chocolate Brown	Light Tan	Tan
Solubility (%)	90	95	——
Moisture (%)	10	10	8
Grease (%)	1	1	——
Ash (%)	6	13	6.5
pH	6.7-7.3	6.5-7.0	——
Protein (%)	77-82	75-80	84-87*
Nitrogen (%)	13-14	12.7-13.5	13.9*

*Anhydrous basis

The production of laminated wood with blood adhesives, right, at Kay Musical Instrument Co. permits easier forming of guitar and bass sides without cracking the outside surface ply.

various bloods, *i.e.*, beef, hog, calf and sheep bloods, accumulated in collecting tanks at the time of slaughter. The first processing step involves the releasing of the fibrinogen from the blood by means of agitation and then screening it out in the form of fibrin just prior to drying the clear blood liquor.

Prepared For Packaging

The fresh defibrinated blood is injected into a spray dryer where, in a matter of seconds, it is transformed into a fine powder ready for packing. The color of this soluble dried blood is maroon. Its uses are as follows:

(1) *Adhesive for Douglas Fir Plywood* — The blood is incorporated in soybean adhesives to increase the water resistance of the glue line. The finished plywood, so glued, will be suitable for sheathing and concrete forms. Blood is also used with phenolic resins in bonding exterior grades of plywood to lower pressing temperatures and give a somewhat shorter pressing cycle.

(2) *Clarifying Agent*—The product is used to clarify chemical liquors. This is done by putting the blood into solution, mixing it with the solution to be clarified, and raising the temperature of the entire mass to 160°F. or more to coagulate the blood into very small particles. As the gummy coagulum settles, it takes with it the suspended matter, thus leaving the solution clean and clear.

(3) *Emulsion Stabilizer* — The asphalt industry uses blood to stabilize an asphalt-water emulsion. Asphalt so processed flows at atmospheric temperatures, thereby simplifying transportation and handling problems. After the water-asphalt emulsion is poured on a highway, for instance, the emulsion breaks and the water disappears, leaving an evenly distributed film or layer of asphalt on the surface.

(4) *Bonding, Spreading and Emulsifying Agent* — Soluble dried blood is used in certain types of insecticides and fungicides as an additive in the formulation to impart extended adhesion to the foliage, to obtain a more even spread, and—in the case of oil-base sprays —to emulsify the oil in the water to insure a light and uniform oil concentration during application operations.

From the time the animal is slaughtered until the available blood is packaged, every manufacturing step is pointed toward cleanliness, speed, preservation and temperature control in order to maintain a high and uniform standard. During drying, the temperature of the blood particle must not rise above 160°F., otherwise insolubilization takes place. True, the air in standard spray dryers is higher than 160°F., but the droplets do not reach the temperature of the drying air because the evaporation of their moisture keeps the temperature down.

Simulate Fresh Blood

The resultant products at time of use should simulate perfectly fresh blood or serum in respect to odor, color, solubility, coagulation, bonding power, keeping properties, and even chemical properties. In order to retain these qualities it is essential that exceedingly close control be maintained during processing because of the sensitivity of blood to possible outside influences.

There are also three grades of insoluble blood produced by the industry for use in feeds and as a fertilizer. They are: ground dried blood, blood meal (finer grind than ground dried blood), and

blood flour (finer grind than blood meal).

These dried bloods are produced by utilizing all types of bloods from the various killing floors. The bloods are dried under intense heat to coagulate them. Because they have been held at elevated temperatures while drying, these bloods are completely insoluble in water and thus differ very materially from the water-soluble products.

One of Largest

Armour and Company is one of the country's largest water-soluble blood producers. It is the sole domestic manufacturer of blood albumin and, therefore, dried blood fibrin. One of the most modern and completely automated blood drying facilities in the world is the Armour installation at its South St. Paul, Minn., meat packing plant.

As shown in the accompanying diagram, blood taken from the kill troughs is pumped immediately into refrigerated stainless steel tanks for processing. The blood flow is controlled by means of a master control board which includes such advances as a Beta Ray installation to assure processing according to exact specifications.

Blood is pumped from the refrigerated tanks (A) through a series of Sweeco Screens (B) to remove blood clots and foreign matter. Next, the liquid blood stream enters a concentrator (C) where moisture is removed leaving 30 to 40 per cent solids. The concentrated blood is then forced under tremendous pressure through jet nozzles at the top of the drying tower (D). Controlled heat immediately dries the spray of blood and the blood particles (100-mesh or finer) settle gently to the bottom of the tower. These blood particles are then conveyed to blenders (E) where the blood is mixed to provide the desired uniformity. It is then conveyed to an automatic bagging machine (F), after which the blood is ready for shipment.

Acknowledgments

The authors wish to express their appreciation for the cooperation of members of the Kay Musical Instrument Co., Chicago, Ill.; American Seating Co., Grand Rapids, Mich.; and Armour Alliance Industries, Adhesives Division, Alliance, Ohio.

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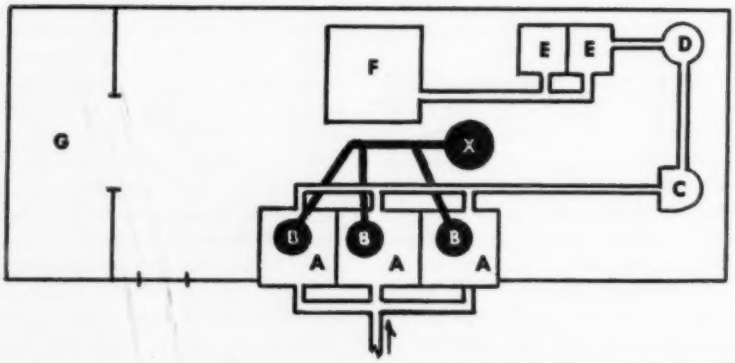
Schematic of Automated Blood Drying Facilities



Notes: A = refrigerated tanks; B = blood clot screens; C = concentrator; D = spray drier; E = blenders; F = bagging machine; G = storage; X = blood clot tank.

Wire tines are bonded between the rubber discs with only two drops of a quick-setting adhesive.

Bonded Wire Whiskers Propel Electric Mouse

An electric "mouse" with bonded wire whiskers is now being used to scamper through the underground ducts of big cities to thread them with electrical cable and communication lines.

Produced by Chicago Pneumatic Tool Co., New York, N.Y., the mouse achieves its motion from traction brushes made by bonding alloy wire or tines between rubber discs. The brushes pulsate at the rate of 10,000 movements per minute. Once in contact with the duct wall, the tine movements create forward motion and drag the mouse and its attached cable along.

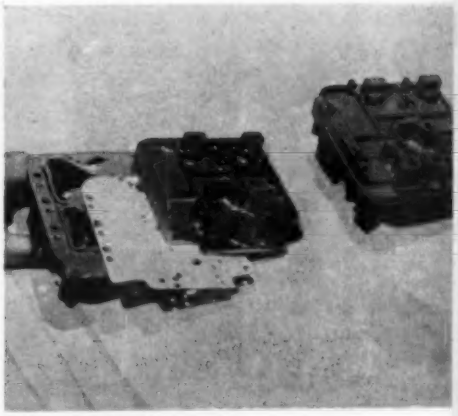
Resists Friction Strains

The secret of the mouse's success is the ability of the wire-rubber bond to resist the strain caused by friction with duct walls. Tines are bonded between the rubber discs with two drops of Eastman 910 Adhesive which sets within eight seconds without heat, solvent evaporation or catalysts.

Originally, the mouse designers tried a less pliable nose piece to hold the tines. Tests showed, however, that the use of bonded rubber sandwiches increased maneuverability.

Adhesive Bonding Manifold Assemblies

Switch to use of a structural film adhesive cuts production costs by over 50 per cent for manufacturer



Unassembled manifold, left, shows the position of the structural film adhesive. The completed assembly is shown right.

Adhesive bonding two mating manifold sections instead of assembling with conventional fasteners and sealers has reduced production costs over 50 per cent per manifold assembly at Taylor Instrument Companies, Rochester, New York. The adhesive assembly techniques not only solved a difficult manufacturing problem, but permitted use of lower cost materials and eliminated field failures and rework of rejected assemblies due to leaking.

The two manifold sections are bonded and sealed with die cut Scotch-Weld Brand structural film adhesive AF-6 made by the Adhesives, Coatings, and Sealers Division, Minnesota Mining and Manufacturing Co., St. Paul, Minnesota. Use of a film adhesive provides uniform thickness throughout the joint and continuous contact between mating surfaces, thus sealing and bonding in a single operation.

The manifold assembly is used in a controller unit which checks a wide range of process variables such as pressure and liquid level.

With the previous fastener and sealing method, individual manifold sections had to be masked, painted and baked before the assembly operation because the sealer used could not withstand the high baking temperatures of the enamel. After this operation the sealer was sprayed on the mating surfaces of the sections which were then assembled with stainless steel screws. Sealer thickness was difficult to control and the assembly had high and low spots. In addition, the recess in the head of each screw required filling to prevent accidental removal in service.

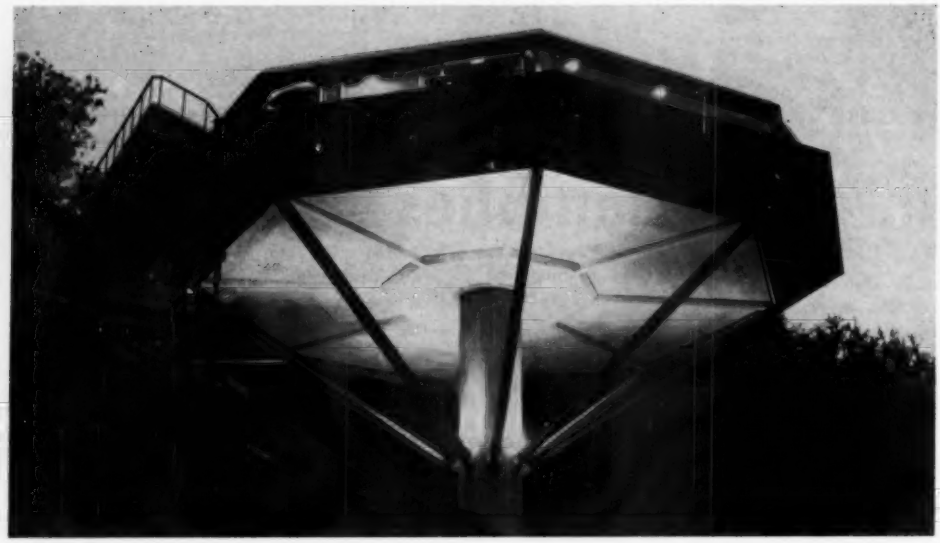
The adhesive assembly method consists of solvent tacking the die cut adhesive film to one mating manifold surface and assembling the two manifold sections with plain steel screws. The screws apply the required pressure for adhesive curing operations. The entire assembly is then spray painted with an epoxy enamel and cured for an hour at 350°F.

Because of the high strength of the bonded assembly (over 3000 psi), the screws could be removed after the curing operation. This is not normally done, however, because the labor cost for removing the screws exceed their commercial value.

Scotch-Weld Brand structural film adhesive AF-6 is an elastomer-phenolic high strength thermosetting dry bonding film adhesive which exceeds military specification MIL-A-5090D for structural bonding and honeycomb sandwich construction. The advantage of a film adhesive in an operation such as that at Taylor Instrument is that in addition to controlling glue-line thickness throughout the joint, it confines the adhesive to the immediate bonding area and makes for clean bonding operations and simple application procedures.

After the film adhesive is positioned, screws are installed to hold assembly and apply pressure during the cure.

A rack of manifold assemblies is pushed into an oven where it will be subjected to a 350°F. cure for one hour.



A Chemically Welded House

A satellite-shaped modern structure that literally is bonded together from roof to base pad was recently "launched" in Hollywood Hills, California. Named Chemosphere, this $100,000 home is probably the world's first "chemically welded" house.

Home of electronic engineer Leonard J. Malin, Chemosphere was designed by architect John Lautner and sponsored by Chem Seal Corporation of America as a demonstration of some of the architectural and construction possibilities of some of the firm's 65 compounds for adhesive, caulking, coating and potting formulations. All of these products are based on chemical formulas calling for varying combinations of polysulfide liquid polymers and epoxy resins.

Owner Malin actually built Chemosphere by himself, using outside help only as needed. It is basically a 2200 square foot octagon perched on top of a 30-foot high, five-foot wide, reinforced concrete column.

One of the most interesting applications of "chemical construction" was the use of an epoxy formulation to bind and seal the supporting column to its thick underground pad. This not only helped meet building code objections to two-part pouring of the foundation, but insured against moisture reaching the reinforcing steel bars in the column and stabilized the footing to withstand strong motion from landslides, earthquakes, high winds and other disturbances.

New Roofing Technique

Epoxy materials were also used in developing a new roofing technique. First, an integrated single-membrane roof formed of wood pulp insulation panels was completely weatherproofed by rolling in a mixture of epoxy and chopped fiber glass. All roof joints were then tightly sealed with fiber glass tape and an epoxy compound. Customary metal gutters were eliminated by covering the whole roof perimeter with tape, and epoxy is used instead of metal flashings around vents. A weather-resistant epoxy coating was then applied over the completed roof to give it a final protective sheath.

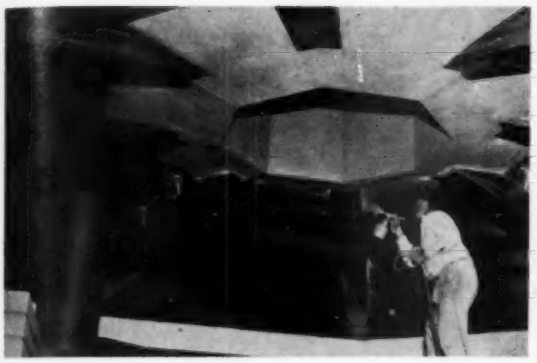
In other applications epoxy formulations were used to bond metal to wood in anchoring laminated roof beams of the structure. Aluminum caps of the beams were sprayed with tan-colored polysulfide compound as protection against oxidation and metal glare.

To provide a 360° picture window with an unobstructed surface, glass mullions, or dividers, were installed around the entire house. The glass-to-glass bond was obtained with a colorless epoxy.

Other applications in which adhesive and coating formulations were used included setting concrete patches in two unfilled areas of the supporting column, seating the supporting frame of steel beams into the concrete column, sealing and bonding window panes to aluminum frames, protecting interior ceiling beams, and setting ceramic tile.

In all, formulations based on epoxy resin or polysulfide liquid polymer, or both, were used in 28 different applications throughout the house.

"Today, it is not only theoretically, but actually possible to construct a whole house with modern adhesives and sealants replacing nails, bolts, screws and other conventional metal and wooden fasteners," points out Fred W. Weber, president of Chem Seal.



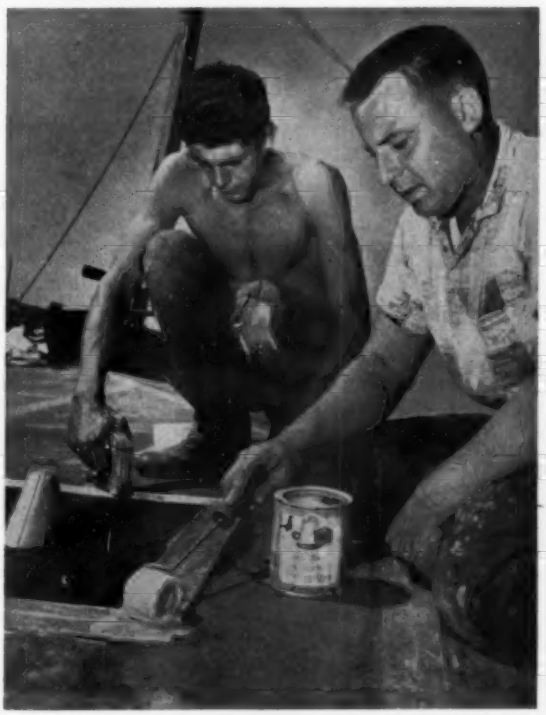
Neutral-stained ceiling beams are sprayed with clear epoxy coating to both protect and beautify them. Shown above is Ted Rocker who did interior and exterior finishing.

Eliminating the need for metal gutters, L. J. Malin applies epoxy sealant to fiberglass taping used with composition wood pulp roof. The house has 2200 square feet of space.

An epoxy was used as an adhesive between the cured concrete and the gunite used to patch two areas that failed to fill in within the framing when the column was poured.

Aluminum caps over laminated beams are sprayed with tan-colored, pourable polysulfide compound which provides a peel-proof coating eliminating glare and oxidation.

Joints of the single membrane roof covering of composition wood pulp are immobilized with fiberglass tape onto which an epoxy sealant was applied by Malin and a helper.



By DUDLEY P. JONES
Shell Chemical Company
New York, N.Y.

Epoxies for the Tiros Satellite

Components, power supply and circuitry in Tiros meteorological satellites are protected against the hazards of space flight by epoxy resin formulations serving as adhesives, coatings, sealants and encapsulations.

Sponsored by the National Aeronautics and Space Administration, the Tiros project has pioneered in the development of improved methods of weather observations by making available for evaluation hundreds of thousands of photographs of cloud formations. As contractor for the Tiros spacecraft and data acquisition equipment, the RCA Astro-Electronic Products Division at Princeton, N.J., has developed and built a completely integrated satellite and ground control system.

9300 Solar Cells

Each Tiros vehicle carries approximately 9300 solar cells to provide power for cameras, recorders, transmitter, infrared and associated equipment. These solar cells have total maximum output of 60 watts under optimum conditions. They are mounted in "shingles" of five cells on module boards carrying 80 cells each. Module boards, in turn, are mounted on aluminum panels—four to a panel.

Tiros module boards are made of a glass cloth-epoxy laminate selected for low-volatility characteristics in high vacuum, since outgassing during space flight would have a harmful effect on functioning of satellite components. Module boards were made with ridges for accurate positioning of "shingles" and to speed their mounting. They were produced by International Resistance Company, Philadelphia, using Shell Chemical Company's Epon resins.

To attach solar cell "shingles" to module boards, and module boards to aluminum mounting plates, a modified epoxy resin structural adhesive was used. Available in sheet form, this adhesive consists of a supported film on a lightweight glass fabric carrier. Designated as FM-97, the adhesive is made by Bloomingdale Rubber Company, Aberdeen, Maryland. It helps protect Tiros circuitry by maintaining a uniform dielectric gap.

Mounting the large number of solar cells and module boards on five Tiros vehicles was a major problem of assembly. To speed operations, the supported film adhesive was cut to size prior to assembly, and refrigerated to preserve its shelf life. Stored at 0°F., the shelf life is at least 225 days; stored at 40°F., the shelf life is at least 60 days.

Assembly of solar cells involved hand positioning a "shingle" of cells and a single precut section of adhesive on a module board cleaned of fingerprints and grease. Each "shingle" was mounted individually until the module board was completed. Light pressure was applied to each assembly by placement of a steel plate over it while being oven cured. This pressure assured contact of the adhesive at all points. A walk-in oven was used at 200°F. for a minimum of five hours.

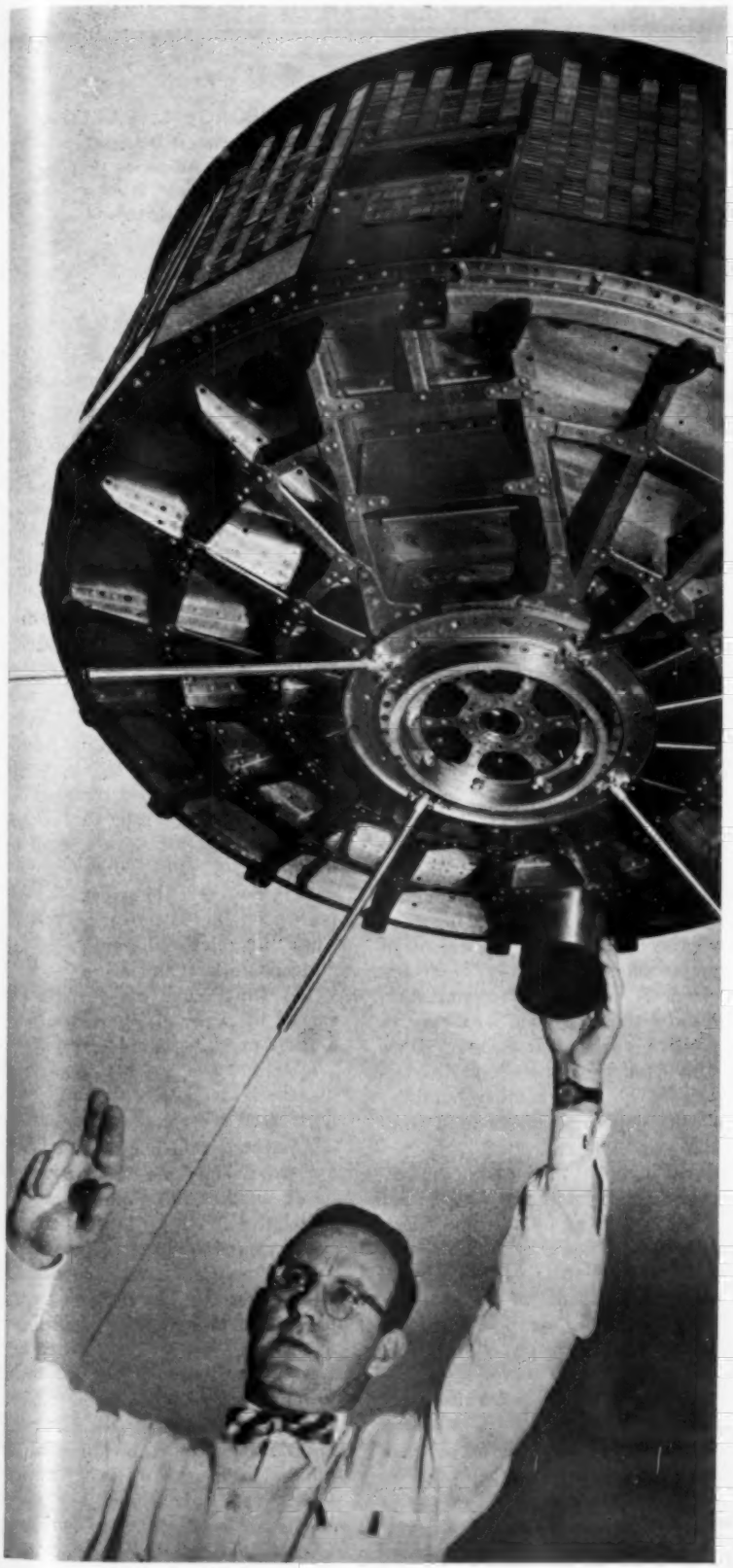
Assembly of completed module boards to aluminum mounting plates was handled in the same manner. The plates had been given a Martin Hardcoat finish. Prior to mounting, the finish had been abraded lightly with medium grit emery cloth and wiped off with solvent.

As a fillet and sealant around solar cells and module boards to stop vibration and fill voids, a high strength, 100 per cent solids adhesive formulation, Bondmaster M 648, was applied. Made by Rubber and Asbestos Corp., Bloomfield, N.J., the adhesive is a two-part formulation based on Epon resins. It was mixed in very small batches because its pot life is 45 to 50 minutes. The fillet material was applied with artists brushes following oven cure of completed modules and mounting plate assemblies. Room temperature cure overnight permitted handling of assemblies.

Protecting Small Parts

For a conformal coating to hold down and protect small parts and wiring, and for encapsulating miniaturized parts, Hysol 12-006, a printed circuit formulation based on Epon resins was employed. Made by Hysol Corporation, Olean, N.Y., the formulation was used to encapsulate or coat as many Tiros components as possible prior to assembly. The remaining parts were coated afterward by brush, spatula or air gun. The gun was needed to apply the thick and viscous oxide-filled formulation of this material that was used around batteries as a heat-sink.

The two-part polyamide-cured formulation was mixed by hand, as required, in quantities varying from 18 grams to one pound. Pot life of the mixture is two and one half to three hours. Coated assemblies were cured at 150°F. for a minimum of two hours in the walk-in oven.



Above, an RCA engineer makes final adjustments on Tiros II which is mounted on a special test machine. Lights above and around the unit test the solar cells at the sides and on top.

Solar cells on the periphery of the satellite shown left are mounted in "shingles" of five on 80-cell Epon resin module boards which are then mounted on aluminum plates by means of an epoxy structural adhesive formulation.

An epoxy resin formulation was used for encapsulation and coating of the tiny parts of the internal electronic system for the satellite. The RCA technician below is putting the finishing touches on the interior assembly.

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The Effect of Relative Humidity on the Drying of Adhesives

Adhesives may be divided into four major categories according to the manner in which they dry. The categories could consist of (1) emulsions, (2) water solutions — true and colloidal, (3) solutions in organic solvents, and (4) chemical cures, such as two-component reactive mixtures or thermosetting adhesives.

To study the effect of humidity on the drying of adhesives, a consideration of the methods of drying is essential. In the case of water emulsions, water is removed from the adhesive and, apparently, due to the crowding effect, the emulsion particles coalesce and the adhesive begins to show drying characteristics such as high tack and adhesion. As the moisture leaves the system the bond strength increases, but a sudden increase occurs when the emulsion particles coalesce.

Progressive Drying

Water solution adhesives (such as dextrine) would also dry by removal of water by the substrate and/or by evaporation, but the drying would be progressive rather than sudden, since there is no sudden "break" in the adhesive system.

Solvent systems would also dry because of solvent removal by the substrate (and/or evaporation), but since the evaporation of an organic solvent is independent of humidity, organic solvent adhesives probably are not affected by humidity.

In the case of chemical cures, such as two-component systems or thermosetting adhesives, unless water enters into the reaction or is present as a solvent, humidity would probably have little effect on drying time.

Since the setting of organic solvent solutions and chemical cure systems is apparently not affected by humidity to any great degree, this study is concerned with the aqueous types only. The adhesive industry is well aware that humidity affects the drying rate of aqueous adhesives. However, the extent of the effect is not generally recognized. A preliminary examination showed that the time necessary to produce a fiber tear on kraft paper with aqueous adhesives varied tremendously as the relative humidity of the paper specimens used were changed.

Throughout this study the expression "drying time" or "tear time" will refer to the time necessary to produce a 50 per cent fiber failure on paper or paperboard using a standardized thickness of adhesive film. Past experience has shown that 100 per cent fiber failure is not always reproducible due to variations in the paper. For evaluations in the laboratory the time necessary to produce a 50 per cent fiber failure is a more reproducible standard. Since the final drying of the adhesive is apparently an evaporation phenomenon and the final bond is always much stronger than the paper itself, *final* drying time will not be considered.

The relationship between the drying of an adhesive and atmospheric relative humidity is rather complex and a thorough study of the substrate is necessary. Before a relationship can be clearly established, many questions must be answered:

(1) What is the relationship between the drying rate of the adhesive and the moisture content of the board?

(2) How fast do paper and paperboard change moisture content when the relative humidity of the atmosphere is changed?

(3) How much moisture is absorbed by paper and paperboard at a given relative humidity?

Basis of Study

This study of relative humidity and the drying rate of adhesives is based on the above questions.

Relative humidity is the percentage expression of the prevailing vapor pressure of water in the atmosphere divided by the total vapor pressure of water in the atmosphere at the given temperature. When the relative humidity is 100 per cent, air is saturated with water vapor, but the amount of water vapor in air varies with temperature, since the vapor pressure of water varies with temperature.

The actual amounts of moisture in saturated air at various temperatures are expressed in the table

below in terms of grams of water vapor per cubic meter of air.

32°F	4.8
41°F	6.8
50°F	9.3
59°F	12.7
68°F	17.1
77°F	22.8
86°F	30.4
95°F	39.6
104°F	51.1
122°F	83.2

This table shows that at 100 per cent relative humidity the amount of actual moisture in the air will more than double when the temperature is increased from 68°F. to 95°F. Since relative humidity is the per cent of moisture saturation of air, when air contains a given amount of moisture, a decrease in temperature increases the relative humidity.

In the packaging industry, adhesives normally produce a fiber tear on paper and paperboard in a very short time — usually in seconds, rarely more than a few minutes. In such a short period of time, water evaporation apparently is not a major factor (at least not directly) because the moisture from the adhesive, sandwiched between paper or paperboard, must penetrate the paper before it can evaporate. Penetration into the paper should be the major factor involved. However, it is probable that the rate of penetration is altered by evaporation.

If penetration through capillary action is primarily responsible for fiber tear, a question is raised as to why an adhesive dries at all in the case of dextrine adhesives. If the liquid is drawn into the paper by capillary action in the liquid phase, the fibers would have to filter out dextrine molecules to promote drying. Otherwise, the paper would merely spread the adhesive over a wide internal surface and evaporation would have to account for drying. Filtration of dextrine molecules by the paper seems unlikely, and evaporation of such a large amount of water in such a short period of time appears questionable. Apparently, the mechanism is much more complex.

Capillary action should be the initial mechanism and this action should fill the large voids of the paper with liquid adhesive.

This writer discussed the problem of drying mechanism with Dr. Walter A. Patrick, The Terraces, Baltimore Md., who offered the following theory to explain the drying of a dextrine adhesive on paper or paperboard. Dr. Patrick believes that the initial step in moisture penetration would consist of the formation of a monomolecular layer of water around the paper fibers (adsorption). Then the voids would begin to fill with moisture, this process continuing until saturation is reached.

A study of the relationship of a paper's moisture content and the time necessary for a fiber tear adhesive bond

In the case of a dextrine solution (colloidal) both the dextrine and water would be pulled into the paper by capillary action, but while the solution is being transported, due to polar attraction and sluggishness of the large dextrine molecules, the paper would tend to hold the dextrine molecules near the glued joint while the water molecules, due to their much greater mobility, would move into the paper. Thus the solids content of the adhesive would continually increase until the bond is strong enough to tear fiber. This would explain the extreme effect of relative humidity, since relative humidity would determine the amount of moisture originally in the paper (and its potential capabilities to absorb.)

Attempts were made to show the degree of dextrine penetration. A dextrine adhesive was allowed to dry on paper and the sample was cleared in xylol, then imbedded in paraffin. Cross sections were cut with a microtome at ten microns, the paraffin removed, and the slides coated with thin celloidin in order to prevent aqueous stains from removing the adhesive. Unfortunately, none of the stains used were sufficiently selective to differentiate between paper fibers and dextrine. Ordinary histological stains were of no help, but the technique shows enough promise to warrant additional work. It would be interesting to know whether the paper segregates dextrine molecules according to size as Dr. Patrick's theory would suggest.

Additional support of this theory is found in the well known effect of adding electrolytes to dextrine adhesives. When salts such as sodium nitrate or calcium chloride are added to a dextrine adhesive, the fiber tear time is greatly increased and the adhesive becomes "slower drying" even though the total solids may be greatly increased. This would be logical in view of the above theory, since electrolytes should attach themselves to the paper fibers and hinder the separation of dextrine and water. The addition of excess electrolytes also greatly increases penetration. On the other hand, non-electrolytes, such as glucose, tend to decrease penetration and "keep the adhesive on the surface."

If the mechanism proceeds through penetration, the next logical step would be evaporation, since the sudden increase in moisture from the liquid adhesive would upset the moisture equilibrium of the paper with the atmosphere and cause the water molecules to leave the paper in the vapor phase. This concept is consistent with observation, since it is a well known fact that if paper is not in equilibrium with the atmosphere, the paper changes moisture content so rapidly that it cannot be weighed accurately on a regular analytical balance. Another observation that tends to support the importance of penetration is that if varnished or foil coated papers are adhered on the *uncoated* side, drying takes place normally even though evaporation cannot take place at its normal rate.

This line of reasoning has led to the assumption that penetration of moisture into the paper from the adhesive is the main mechanism, and since the moisture content of paper is a function of relative humidity, a mathematical relationship should exist between relative humidity and the drying rate.

If a piece of dry paper is exposed to an atmosphere of 50 per cent relative humidity, and a piece of very moist paper, cut from the same original sheet, is exposed to the same atmosphere, the two pieces of paper will not have the same moisture content when equilibrium is reached. If strips of paper are taken to zero per cent relative humidity, then exposed to various atmospheric relative humidities and the increase in moisture in the paper is recorded, an S-shaped curve results when the moisture content of the paper is plotted against relative humidity. Brecht[1] has shown that when the same paper is changed from 100 per cent relative humidity to various atmospheric relative humidities a similar S-shaped curve results, but the two curves meet only at the two extremes (zero per cent and 100 per cent relative humidities, in the case of Brecht's experiments). See Figure 1.

Since a hysteresis curve results, consideration must be given to the original state of the paper or paperboard before moisture content change. If the drying time of an adhesive is a function of the moisture content of the paper, this hysteresis effect will be extremely important because it will mean that two pieces of paper cut from a sheet can have different moisture contents even though they are in equilibrium with the same atmosphere, depending on their previous exposures to moisture. Before any attempt is made to study the drying rate of adhesives, the equilibrium moisture content must be determined for each type of paper or paperboard studied. This experimental study is particularly important since little information is available concerning the moisture relationships of the paperboards commonly purchased by adhesive users.

Experiment 1

Object: To plot the moisture content of selected papers and paperboards as the relative humidity is varied and to show the hysteresis effects.

Preliminary examination: The use of ovens, infrared, or other destructive drying methods was purposely avoided for obtaining zero per cent relative humidity equilibrium. The original approach was based on the use of atmospheres of designated relative humidities in desiccators. Known concentrations of sulfuric acid provided the proper vapor pressures, with concentrated sulfuric acid providing the zero per cent relative humidity.

Hastening Paper Equilibrium

Since the time necessary to reach equilibrium was not known, (especially for paperboards) the desiccators were originally evacuated to 20 inches of mercury to hasten equilibrium of the paper. Strips of papers and paperboards were brought to zero per cent relative humidity under vacuum and weighed in weighing bottles. They were then brought to 20, 40, 60, 80, and 100 per cent relative humidities to determine the moisture content. The experiment was a failure, for when the vacuum was broken, the sudden influx of air from the atmosphere changed the weights before the lids could be placed on the weighing bottles. However, several things were learned from the experiment:

(1) The method itself was sound and had good possibilities.

(2) One hundred per cent relative humidity is very difficult to maintain because the slightest drop in temperature results in dew formation and condensation takes place directly on the paper, giving erratic weights.

(3) Paper and paperboards exchange moisture with the atmosphere very rapidly and conventional laboratory weighing procedures are not reliable unless extreme precautions are taken.

(4) If vacuum is used, the air used to break it must be of the same relative humidity as the space under vacuum.

(5) Much emphasis must be placed on the attainment of zero per cent relative humidity, for if the paper is not at zero per cent relative humidity all of the calculations will be incorrect.

The experiment was as follows:

Procedure—The eight papers and paperboards selected were: clay-coated ground-wood paperboard; clay-coated chipboard; chipboard with bleached Manila lining; solid bleached sulfate with bleached kraft skin; tan chipboard; solid bleached sulfate; 60-lb. kraft paper; and 16-lb. typing paper.

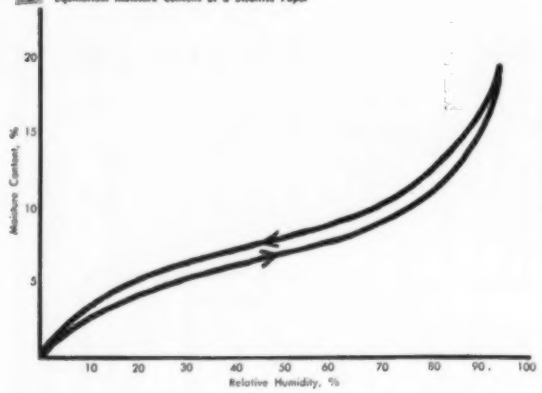
Forty weighing bottles were marked and five strips of each of the above materials were individually placed in weighing bottles. The open weighing bottles were placed in desiccators over concentrated sulfuric acid and a vacuum of 20 inches of mercury was drawn. After 24 hours the vacuum was broken by passing air through sulfuric acid, through phosphorous pentoxide and into the desiccators which were then allowed to stand for an additional 24 hours at atmospheric pressure. The desiccators were then opened and the weighing bottles were immediately sealed and weighed. Moisture changes by the glass weighing bottles were considered. This gave the weights of the strips at zero per cent humidity as obtained from an atmosphere of zero per cent relative humidity.

By varying the concentrations of sulfuric acid, desiccators were arranged with 20, 40, 60, 80, and 90 per cent relative humidities. Using the above procedure without vacuum, the samples were brought back to zero per cent relative humidity because each sample had been briefly exposed to the atmosphere to take the weight of the empty weighing bottle. They were then placed in the designated humidity desiccators. After 48 hours the samples were weighed to get the per cent moisture *gain*.

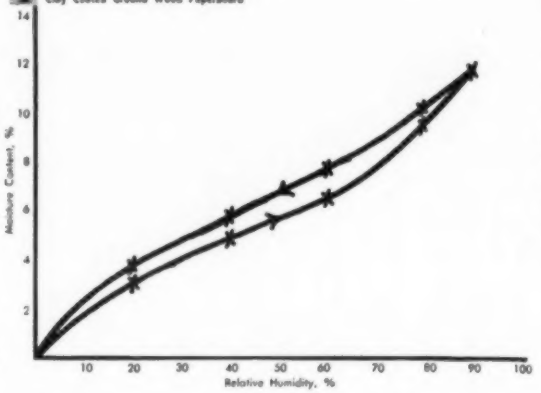
The samples were then taken to 90 per cent relative humidity, using vacuum, and the above procedure was used. Moist air was used for breaking the vacuum. They were then brought down to the designated humidities. This gave the per cent moisture content when the samples *lost* moisture. The entire experiment was performed at 86°F.

Results: The results of the experiment are plotted in Figures 2 through 9.

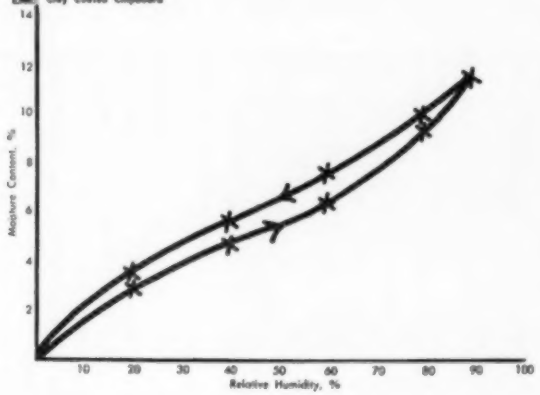
1 Equilibrium Moisture Content of a Bisulfite Paper



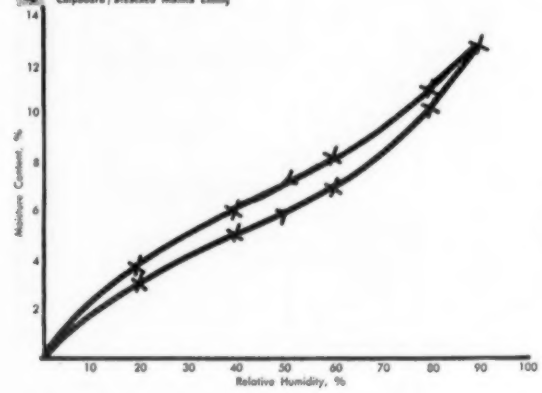
2 Clay Coated Ground Wood Paperboard



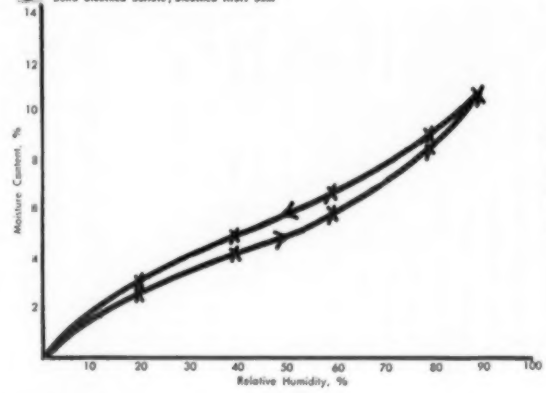
3 Clay Coated Chipboard



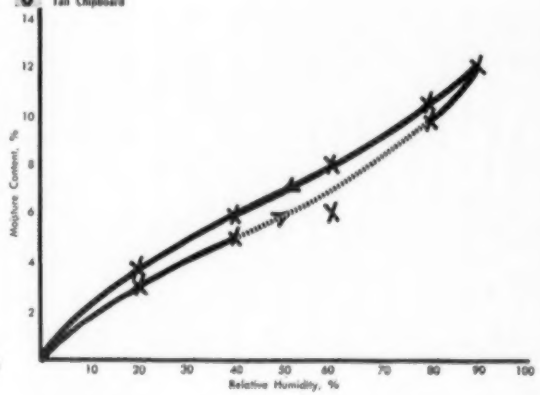
4 Chipboard / Bleached Manila Lining



5 Solid Bleached Sulfate / Bleached Kraft Skin



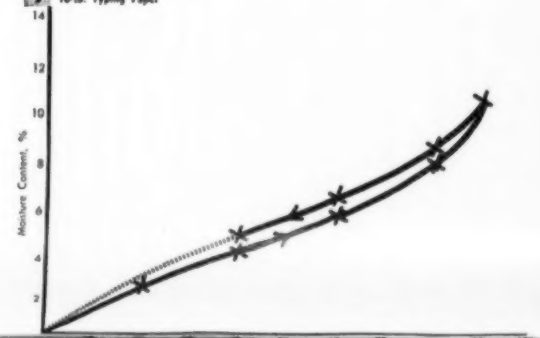
6 Tan Chipboard



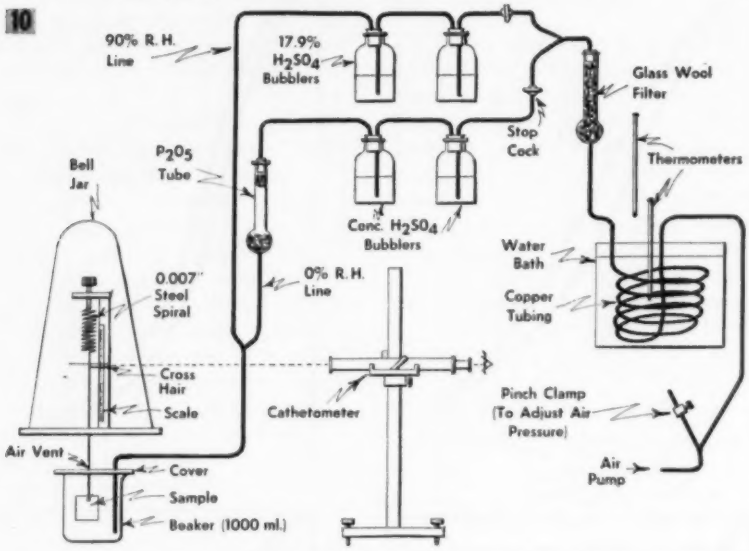
7 Solid Bleached Sulfate Board

8 60-lb. Kraft Paper

9 16-lb. Typing Paper



Set-Up of Laboratory Apparatus for Experiment 2



If these curves are compared to the curve obtained by Brecht it will be seen that agreement is very close until 80 per cent relative humidity is reached. Since 90 per cent relative humidity was the maximum used, the curves were forced to meet at 90 per cent, while Brecht's curve is apparently based on 100 per cent maximum.

If the curves are compared to each other it will be seen that they are all very similar with the exception of kraft paper which has a higher moisture content than the other papers and boards. Surprisingly, the clay-coated boards behaved very similarly to the uncoated boards. Even typing paper showed the same type of curve with little variation.

Vacuum Desiccators

No attempt was made to find the actual time necessary to reach equilibrium; however it is possible that by using vacuum desiccators the equilibrium is attained very rapidly. Once the equipment is set up, breaking the vacuum with the proper air can be done very easily. This method may not agree with oven or infrared technique; no attempt was made to show a correlation. In this study the weight of paper and paperboard at equilibrium with zero per cent atmospheric relative humidity was desired and if a trace of moisture existed at zero per cent atmospheric relative humidity, it was ignored.

Papers and paperboards establish moisture equilibrium with the atmosphere. However, in order to evaluate the relationship between the relative humidity of the atmosphere and drying rate of an adhesive, the rate at which equilibrium is attained should be known for the papers being studied. In most instances when adhesives are applied to paper and paperboard, equilibrium is *not* reached.

For example, a folding box manufacturer receives his paperboard in stacks with a moisture content of perhaps five per cent. A low atmospheric relative humidity would be necessary to maintain this five per cent moisture in an *individual* sheet. During the manufacture of the box (including the printing) the sheets are individually removed from the stack and exposed to the prevailing atmosphere several times.

The question then arises, how fast does the paper change, and has the moisture content risen above five per cent by the time the adhesive is applied? Also, to evaluate adhesives comparatively, the rate must be known so that laboratory tests can be accurate, reproducible, and meaningful.

Renard[8] has shown that the rate of moisture gain by paper is exponential and follows the relationship:

$$\frac{h_1 - h}{h_1 - h_0} = e^{-kt}$$

where, h_1 = relative humidity of the atmosphere, h = humidity of the paper at the instant t, and h_0 = initial humidity of the paper.

Renard also studied the moisture changes that take place in a ream of paper (47 inches by 31 inches) when the ream is stored at 70 per cent relative humidity. After one month the ream had shown little change at the center, although the moisture content of the outer edges was significantly higher. After six months the center of the ream had changed from 26 to 45 per cent relative humidity. However, the outer edges of the ream approached equilibrium much more rapidly. This is well known to printers who have experienced wrinkling from a sheet of paper with a "dry" center and "wet" edges.

When a sheet of paper or paperboard is studied individually a much different and faster rate obviously exists. Since this rate must be known in order to evaluate the relationship between the drying rate of an adhesive and relative humidity, the next experiment was performed on the papers and paperboards selected for testing.

Experiment 2

Object: To determine the rate of moisture gain and moisture loss of papers and paperboards when exposed to atmospheric relative humidities of zero and 90 per cent.

Preliminary Examination: Originally a Voland Universal balance was used. Paper samples (dried according to Experiment 1) were suspended in the balance and the time was plotted against weight, but due to poor circulation in the balance the results were not reproducible. A steel spiral balance accurate to one milligram was built and attempts were made to provide a slow moving draft at a known relative humidity. This proved to be a better method and the final apparatus used is described below:

Procedure: Apparatus was arranged according to Figure 10. The air compressor tended to heat the air so a copper tubing cooling bath was used. The water bath and room temperature were maintained at 77°F.

As can be seen in the drawing, the relative humidity in the beaker can be changed from zero to 90 per cent, or reversed, by manipulation of the stop cocks. Since the air is continually swept from the beaker the atmosphere does not interfere, even though the system enclosing the paper test sample is not air tight.

Preparing Experiment

The eight papers and paperboards used in this experiment were the same as those used in Experiment 1. Strips of approximately 0.7 grams were cut and placed in weighing bottles. The bottles were placed in a 90 per cent relative humidity desiccator and were brought to equilibrium according to the method used in Experiment 1. The beaker under the spiral balance was brought to 90 per cent relative humidity and the strip of paper was removed from the sealed weighing bottle and hung on the balance. The weight was recorded. The stop cocks were reversed and a stop watch was started. The weight was plotted against time for each of the above papers and paperboards. The strips were then brought to zero per cent relative humidity and the rate of change to 90 per cent relative humidity was recorded. The rate of air flow over the sample was ⅓ inch per second.

Results: The results are shown in Figures 11 through 18. The rate of moisture gain was compared to Renard's equation and the agreement was very good. The value calculated for k was quite different from Renard's constant but this could be expected since Renard studied rate changes in a still atmosphere while this experiment is based on moving air. The rate of air movement in this experiment was the fastest possible without creating erroneous readings in the spiral balance.

However, even with this slow movement of air in the experiment, the papers and paperboards change moisture content quite rapidly. With the extremely rapid flow of air that occurs when paper rushes through processing equipment, moisture changes would be expected to occur very rapidly. Thus, while an individual piece of paperboard may be exposed to the air for only a very short time prior to adhesive application, significant moisture changes may have occurred.

The curves indicate that thin papers tend to gain moisture faster than they lose it, while paperboards tend to gain and lose at approximately the same rate.

When adhesives are compared in terms of the time necessary to develop fiber tear in a laboratory, they are normally compared side by side, at the same time and preferably on the same piece of paper. Otherwise the results can easily be meaningless. It is common occurrence to have an adhesive tear fiber in 20 seconds on Monday and 40 seconds on Tuesday even though the same paper was used. It is also common occurrence to have a reliable adhesive chemist say that a given adhesive tears fiber in 90 seconds, while a customer is getting a full fiber tear in 30 seconds with the same film thickness, same paper and same adhesive.

Obviously, relative humidity must be standardized for reproducible results, but in most cases relative humidity cannot be standardized by the adhesive user. Therefore it is very important to know what to expect of an adhesive when relative humidity is varied.

Experiment 3

Object: To determine the effect of relative humidity on the fiber tear time of adhesives on papers and paperboards.

Procedure: The eight papers and paperboards used in the previous two experiments were cut into four-inch by six-inch pieces. They were handled with rubber gloves. The samples were brought to 90 per cent relative humidity, then placed in desiccators of zero, 20, 40, 60, 80, and 90 per cent relative humidity and held at 77°F. until they reached equilibrium.

A room ten feet by ten feet by 15 feet was dried with 50 pounds of sodium hydroxide. The relative humidity was finally lowered to 20 per cent, but due to the great difficulty of removing moisture, humidities lower than this were not attempted.

At 20 per cent relative humidity and 77°F. the room was sealed and the 20 per cent relative humidity desiccator was opened. The papers and paperboards were then tested for the time necessary to produce a 50 per cent fiber tear at 0.001 inch wet film thickness. A low viscosity borated dextrine adhesive of approximately 30 per cent solids and a polyvinyl acetate emulsion with ten per cent dibutyl phthalate added were used for testing.

By alternately cooling and adding live steam, the room was then adjusted to 40, 60, 80, and 90 per cent relative humidity at 77°F. The corresponding desiccators were opened and the samples were checked for the time necessary to produce a 50

About the Author . . .

GEORGE L. BARLOW is technical director of Monumental Adhesives Co., Inc. Previously he held positions with Penniman & Browne, analytical chemists, in the paint testing division, and with Inter-Coastal Paint Corp. He joined Monumental as a research chemist and was appointed to his present position in 1960.

per cent fiber tear at 0.001 inch wet film.

Results: After the experiment had been completed, attempts were made to plot the results (relative humidity vs. drying time), but a series of scattered, unrelated points resulted.

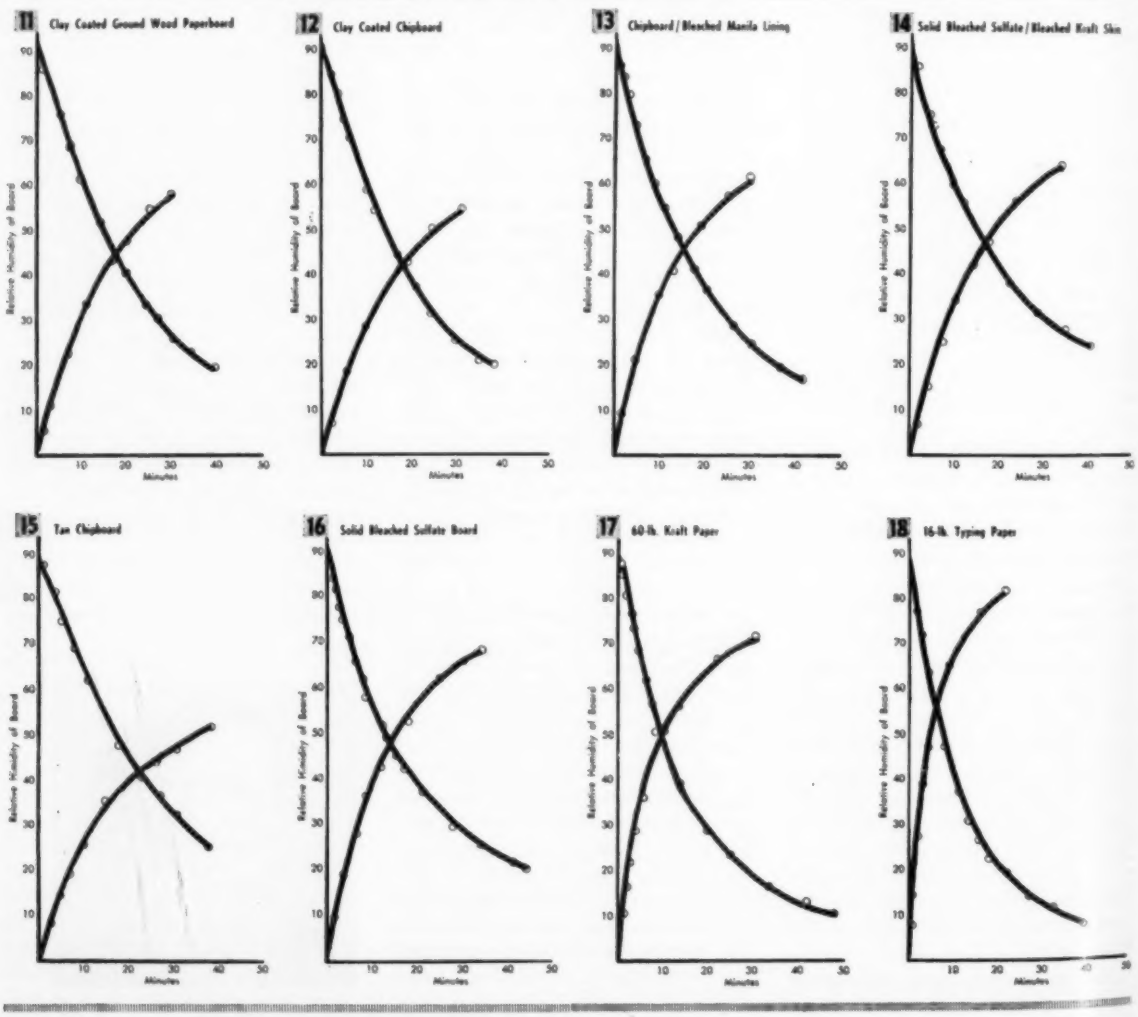
The moisture content was calculated for each of the papers and paperboards and the filter tear time in seconds was plotted against moisture content. The results are shown in Figures 19 through 34.

In plotting the data, a straight line was drawn from the origin through the points as closely as possible, and they are surprisingly close to the straight line. This would clearly indicate that the time necessary to produce a fiber tear is directly proportional to the moisture content of the paper. The graphs would also indicate that at zero per cent moisture the time necessary to produce a fiber tear is near zero. This may or may not be true; however, the experiment clearly indicates that the error could not be great.

An interesting point brought out by Figures 32 and 34 is that the last point is completely out of line with the other points. This could be explained by the fact that paper must have a saturation point—obviously paper will hold only a certain amount of water. This writer believes that the paper had approached moisture saturation, thus greatly retarding the drying time. Penetration was no longer a factor but evaporation was necessary to promote further drying.

Note that this phenomenon occurred only with kraft paper and typing paper, not with any of the boards which could absorb much more moisture. It must be kept in mind that the per cent moisture shown in the graphs is the initial amount in the paper. The more moisture present initially, the less added moisture is necessary to saturate the paper.

With such a simple relationship, mathematical equations are not necessary; merely a direct proportionality. If an adhesive requires 30 seconds to tear fiber when the


11 Clay Coated Ground Wood Paperboard
12 Clay Coated Chipboard
13 Chipboard / Bleached Manila Lining
14 Solid Bleached Sulfate / Bleached Kraft Skin
15 Tan Chipboard
16 Solid Bleached Sulfate Board
17 60-lb. Kraft Paper
18 16-lb. Typing Paper
Relative Humidity of Board
Minutes

moisture in the paper is four per cent, it will require approximately 60 seconds at eight per cent, provided saturation has not already been reached.

If Figures 19-34 are studied, a question arises concerning the relationships. It would seem odd that when fiber tear time is plotted against initial moisture content, a straight line is produced with paperboard while a curve is produced with paper. To explain this apparent discrepancy the following calculations were made.

If a film of dextrine adhesive (30 per cent solids) 0.001 inch thick is sandwiched between two pieces of typing paper each measuring one square inch, the film of adhesive contains approximately 12 milligrams of water initially. In the course of drying, the paper can absorb up to 12 milligrams of water, which would increase the moisture content of the paper about 16 per cent.

Interpreting Data

An examination of Brecht's curve (Figure 1) shows that paper contains approximately 20 per cent moisture at 100 per cent relative humidity. This 20 per cent moisture may or may not be the saturation point of the paper but it definitely shows that the addition of 16 per cent moisture to paper would establish a very large difference between the relative humidity of the paper and the relative humidity of the atmosphere, which would produce a large loss of moisture from the paper.

Under these conditions, therefore, evaporation would become an important factor, contrary to paperboards where the 12 milligrams of added water would produce only a small increase in moisture of the paperboard. For example, only two and a half per cent increase would be produced with solid bleached sulfate board. A 50 per cent fiber tear would require the removal of less than 12 milligrams of water from the adhesive and the 12 milligrams represents the maximum amount that can be removed.

In the above sandwich of paper and adhesive an equation can be derived by letting:

m_i = The initial amount of moisture (gms./2 sq. in.) in the paper.

m = The moisture (gms./2 sq. in.) added to the paper by the adhesive at time t.

m_f = The total amount of moisture (gms./2 sq. in.) that will saturate the paper.

Then, $m_f - m_i - m$ = the potential amount of moisture that can be absorbed by the paper.

Since dm/dt is the change of moisture content with respect to time, then

$$(1)\quad \frac{dm}{dt} = a(m_f - m_i - m)$$

disregarding the evaporation of moisture from the paper. Integration of the equation produces

$$\frac{1}{m_f - m_i - m} = be^{at}$$

When t is zero, m is zero, therefore,

$$b = \frac{1}{m_f - m_i}$$

and

$$(2)\quad \frac{m_f - m_i}{m_f - m_i - m} = e^{kt}$$

Equation 2 is based on m and t as variables. However, if m_i becomes the independent variable and m_f and m become constants, t becomes the time necessary to produce a fiber tear. This would conform to the experiments because a given paper with a given adhesive would have a constant m_f and m (m is constant because the removal of a fixed amount of water from the adhesive produces fiber tear).

There are a number of mathematical derivations that could be made from Equation 2 but the important point is the analysis of the equation itself. $m_f - m_i$ is the amount of moisture that can be absorbed by the paper initially (before the adhesive is applied), and $m_f - m_i - m$ is the amount of moisture that can still be absorbed after the fiber tear has developed. Thus, e^{kt} is equal to the initial moisture potential divided by the final moisture potential.

In the case of thin papers the final moisture potential will be very small, which will cause t to be large. In the case of thick paperboards the final moisture potential will be large and t will be small. It must be kept in mind that evaporation will also take place which will alter the value of t. However, the purpose of the equation is not to calculate t but to show why t changes.

In reference to Figures 19-34, it becomes obvious that the straight lines actually are curves that curve upward slightly, but for practical purposes they may be regarded as straight lines.

The number of mathematical manipulations that can be made concerning moisture relationships is extremely large and is beyond the scope of this paper, but this writer sincerely hopes that this data will offer a starting point for a much deeper investigation of the effects of relative humidity on the drying of adhesives.

Summarizing Data

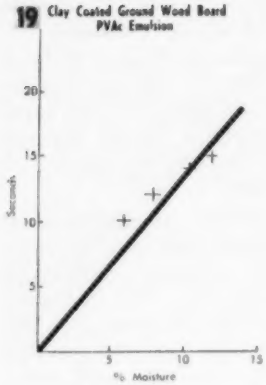
From all indications, penetration is the primary mechanism that accounts for the development of a fiber tear with aqueous adhesives on paper and paperboard.

The moisture change in an individual sheet of paper follows a hysteresis curve and the most rapid changes are at very low and very high relative humidities. Both papers and paperboards show these characteristics.

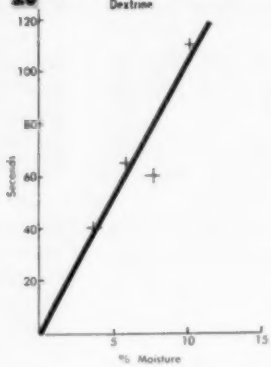
The practice of assuming that a ream of paper or a stack of paperboard is not seriously affected by relative humidity for a few months is apparently sound. However, extreme conditions can account for warpage in the sheet and printing difficulties due to distortions.

An individual sheet of paper or paperboard exchanges moisture with the atmosphere quite rapidly; however, the rate of change is exponential and becomes less as the difference between the relative humidity of the paper and the relative humidity of the atmosphere decreases. Since the rate of moisture exchange depends on the rate of air flow over the paper as well as the difference in the humidities, a piece of paper or paperboard passing rapidly through a folding box machine or a printing press may change moisture content significantly in a very short time. The rule of thumb that "a ream of paper is moisture stable for several months" must be applied to the ream and not to individual sheets. Under proper conditions a sheet of paper can change moisture content significantly in a matter of seconds.

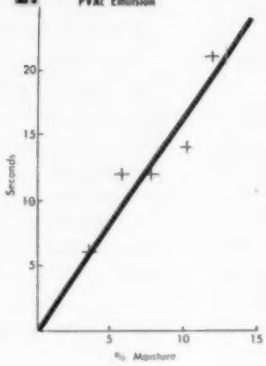
19 Clay Coated Ground Wood Board
PVAc Emulsion



20 Clay Coated Ground Wood Board
Dextrine



21 Clay Coated Chipboard
PVAc Emulsion



22 Clay Coated Chipboard
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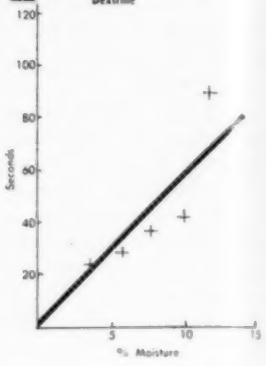
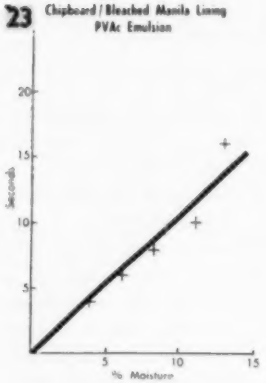
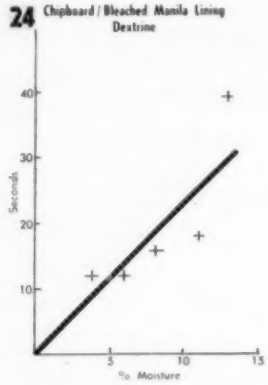


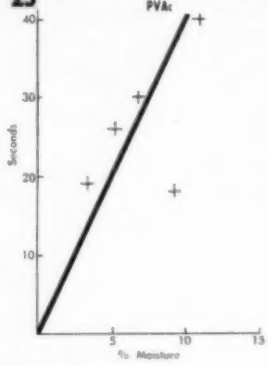
23 Chipboard / Bleached Manila Lining
PVAc Emulsion



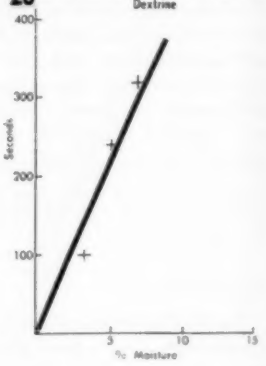
24 Chipboard / Bleached Manila Lining
Dextrine



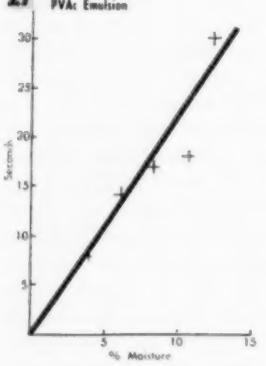
25 Solid Bleached Sulfate / Bleached Kraft Skin
PVAc



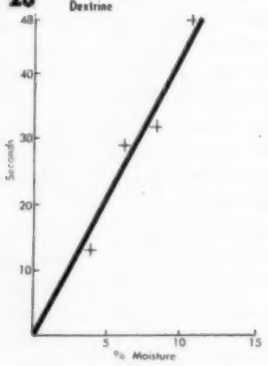
26 Solid Bleached Sulfate / Bleached Kraft Skin
Dextrine



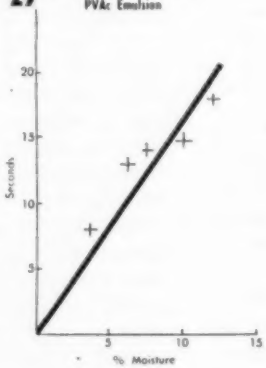
27 Tan Chipboard
PVAc Emulsion



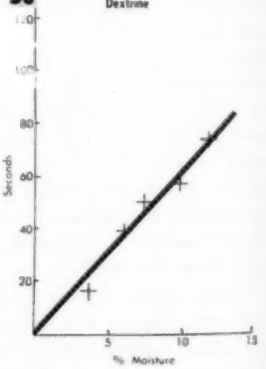
28 Tan Chipboard
Dextrine



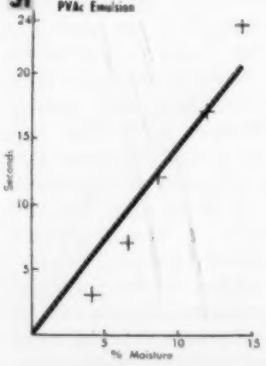
29 Solid Bleached Sulfate Board
PVAc Emulsion



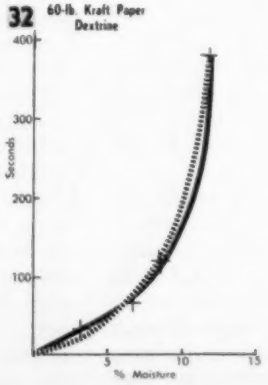
30 Solid Bleached Sulfate Board
Dextrine



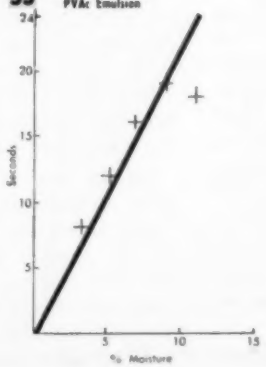
31 60-lb. Kraft Paper
PVAc Emulsion



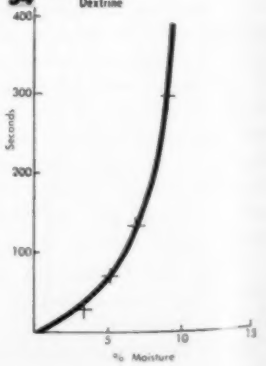
32 60-lb. Kraft Paper
Dextrine



33 16-lb. Typing Paper
PVAc Emulsion



34 16-lb. Typing Paper
Dextrine



The time necessary for an adhesive to develop fiber tear is apparently directly proportional to the moisture content of the paper or paperboard, provided the paper does not approach moisture saturation. This study indicates that the phenomenon of saturation does not occur with paperboards when adhesives are applied at normal film thicknesses. Even with 16-pound stock the moisture content of paper must be rather high before saturation occurs. With high solids emulsions, saturation did not occur in any of papers or paperboard tested, since the removal of a small amount of water resulted in fiber tear.

This data probably creates more questions than it answers, but if the relationship of relative humidity to the drying of aqueous adhesives can be better understood some of the perplexing problems of the adhesive industry may also be understood and solved.

Acknowledgements

I am deeply indebted to Walter A. Patrick, Ph.D., Professor Emeritus of Chemistry, Johns Hopkins University, for acting as my advisor in this study. His many years of experience with moisture retention by silica gel and moisture-sensitive materials aided greatly in planning experiments and interpreting data.

I would like to thank: Edward S. Hauber, S.J., Professor of Chemistry, Loyola College, Baltimore, for the loan of some of the more specialized equipment used; my wife, Marian Barlow, for a study of adhered paper using histological techniques and for making French translations; Mr. Harold Stone, Executive Vice President, Monumental Adhesives Co., Inc., for his helpful suggestions regarding the application of these results; and Mr. Herbert Jones, Production Manager, Potlatch Forests, Inc., Baltimore, Maryland for supplying the paper samples used.

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(1) Brecht, The Influence of the Relative Humidity of the Air on Paper, "Das Papier Wereld," Vol. 13, No. 2, pp. 35-41.

(2) Renaud, J., The Influence of Humidity on Printing Papers, "Assoc. Ind. Papetiere," Bulletin No. 4, pp. 201-14 (1959), Papetiere Chantraine, Aisne, France.

The non-skid, protective coating of epoxy on the road area shown above reduces the cost of maintenance and adds a new dimension of safety for motorists.

Epoxy surfacing material is sprayed on to the Parkway bridge decks. Only one lane at a time need be closed to traffic for a few hours.

Epoxy Coating Helps Reduce Highway Maintenance

A special program to protect more than 400 bridges on the Garden State Parkway against deterioration by coating roadway areas with epoxy resin is being considered by the New Jersey Highway Commission. Approval of the program depends upon the continuing successful performance of test bridges given the special protective treatment in the Fall of 1960.

Epoxy resin seals the roadway against salt and water penetration, thereby protecting the concrete surface. In addition, emery grit embedded in the coating forms a non-skid surface that provides added safety to high-speed travel.

Working in co-operation with engineers of Union Carbide Plastics Co. and the Hunter-Bristol Division of Thiokol Chemical Corp., the Highway Authority chose the epoxy coating because in addition to its wear resistance it has the ability to withstand expansion and contraction of concrete without cracking or chipping. As a result, maintenance problems and inconvenience to motorists is expected to be reduced.

H. W. Goldberger, Engineer of Maintenance for the Highway Authority noted additional advantages. "The epoxy coating is simply sprayed on," he said. "Because it hardens in a matter of hours, traffic lanes can be quickly reopened. Furthermore, our regular maintenance crews can economically apply the coating."

Expected Longevity

The resin surface is not expected to show signs of wear for at least five years. Two bridges and two overpasses have already received the epoxy face lifting. The bridges are those spanning the Mullica and Bass Rivers. Each about one-fifth of a mile long, they are among the longest in the Parkway system.

By JOHN H. GRAHAM
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An Architect Looks at Bonding Agents for Interior Surfaces

Our firm was among the first to utilize modern bonding materials to accomplish the finishing of interior surfaces on large scale construction buildings. Back in 1952, we were prevailed upon to use a bonding material to finish the ceilings, walls, and columns of a twelve-story concrete structure in Syracuse, New York. Built by the Turner Construction Company the structure contained a total of 365 so-called luxury-type apartments with a total floor area of approximately 250,000 square feet.

Originally, we provided the following specification under the lathing and plastering section:

> Plaster bond finish obtained by removing surface of concrete to depth of approximately 1/16-inch. Treatment may be mechanical such as hacking, or chipping; or may be accomplished by applying cement retarder compound to inside of forms.
>
> When a retarder compound is used, and upon removal of forms, all loose surface material shall be removed by wire brushing, until rough bonding surface of exposed aggregate is obtained. Use plaster bond finish for all vertical or overhead concrete surfaces that are to receive an applied finish of mortar or plaster after forms are removed.

Needless to say, when a new method of bonding finish plaster to poured concrete surfaces was presented to us, we were definitely interested. The economic saving, including time and labor, would obviously be considerable.

Laboratory data furnished indicated that the new bonding material was much stronger than any requirement that might be needed to hold up a finish thin coat of plaster. However, before making our decision to try these new, revolutionary adhesives, we inspected an existing job where ceilings and walls in an old hotel had been renovated using this material. Discussing the performance of the material with the building owner, the contractor, and the plasterer who actually used the material, we obtained full assurances that the bonding product would perform satisfactorily.

We were convinced, and made a change in specification allowing the contractor to apply the bonding material directly to the concrete surfaces and the finish coat of plaster to the bonding material.

Inexperience of Help

The only difficulty experienced on this job was due to the inexperience of plastering mechanics in this type of application. In normal plastering, the plasterer depends on mechanical keying and suction developed to hold the succeeding coats of plaster. With the new bonding method, very little suction is developed. The adhesion of the finish plaster is due to a mechanical keying that results when the wet plaster re-emulsifies the bond film, and by the chemical-adhesive bond that is established after plaster and bond film dries.

Since that time, in those projects which our design studies indicated would be most economically constructed using Portland cement concrete, frame and flat plate construction, we have specified agents. By specifying the use of bonding agents to bond finish coat of plaster to the structural walls, columns and ceiling members we have obtained considerable savings in labor and material.

For example, in most areas it is economically feasible to design and build concrete buildings up to 22 stories and even higher under certain conditions. Surfaces produced in building the structural frame of a concrete building require a minimum of finishing, and are most pleasing to the eye.

A number of years ago, there was a trend to chip, grind, and polish these surfaces and use them as the completed room finish. This proved to be much more economical than using the traditional metal lath, and two or three coats of plaster—and it eliminated much of the plaster and labor costs. However, the appearance of such finish surfaces left much to be desired.

With the introduction of the modern method of bonding plaster directly to the poured concrete walls, a rebirth in demand for plaster finished surfaces took place—due primarily to the unsurpassed beauty of plaster. In addition, finishing poured concrete surfaces with a bonding agent and a thin coat of finish plaster proved to be more economical than it was to grind down, rub, dress-up and paint the bare concrete.

Recently, our firm designed the Park Towne Place Apartments. A $17½ million group of 19-story apartment buildings, totaling some 1,000 living units. Flat plate reinforced concrete construction was determined to be most economical for this redevelopment project in downtown Philadelphia, Pennsylvania. We elected to use bonding agents to apply a thin coat of white lime-putty plaster directly to the concrete.

In the construction of this project, the general contractor utilized plywood forming for the concrete columns and floor pours. His variation in surface tolerances was limited to ¼-inch in four feet. This tolerance was deemed necessary in order to allow finishing the concrete surface by applying a minimum thickness of plaster directly to the concrete bonding by means of a plaster bonding material. It was not a hardship on the general contractor. On the contrary, it was felt that having a specification for forming in the over-all construction program allows for neater and more ably supervised building.

Concrete surfaces were turned over to the plastering contractor in such condition that he only needed to spray, using a plaster bonding agent, and apply lime-putty plaster directly to the bonded surface. This operation is immeasureably cleaner, faster and more economical.

In this day and age of large scale construction projects involving large scale loans, especially on speculative housing, construction time becomes an all-important factor. Interest rates on large volume loans of capital make it imperative that the project be completed and opened for occupancy as rapidly as possible. We feel the use of this modern method of bonding in this type building results in a saving of time unequalled by any other means of surfacing.

As far as individual decoration is concerned, again this method is most efficient. The very thin coat of plaster takes a minimum of time to dry and be in condition for painting or papering.

Philadelphia Project

In the North Triangle No 1 Redevelopment Project in Philadelphia, flat plate concrete slab and column construction was used. All exposed concrete columns, ceilings and walls were finished using a skim coat of plaster bonded to the surface using liquid bonding agents. Exceptions were the top floors of each building and the ceilings in the ground floor where commercial establishments were installed.

The two levels required drop ceilings to handle additional insulation, air conditioning and lighting equipment. Incidentally, we have found no problem in utilizing concrete surfaces as finish surfaces where electrical conduits are installed in concrete.

Among the projects which we now have on the board, is one we designed for the United States Air Force in Bermuda at the Kindley Air Force Base. It consists of 180 dwellings units for surplus commodity family housing and includes group housing, single-detached houses, and multi-story apartments.

The specifications as to bonding agent are as follows:

> Bonding Agent—Shall be a resinous water emulsion adhesive bonding agent that will permanently bond plaster material to wet or dry concrete surfaces. Such material shall have a viscosity about equal to that of ordinary paint and shall be suitable for brushing or spraying. It shall be inert to oxygen and perfectly stable when water has dried out.
>
> It shall lose none of its flexibility or adhesive strength and shall be completely free from any tendency to harden or craze-crack. It shall be vermin-proof, non-toxic, non-deteriorating and incapable of supporting flame. Certificate of compliance with these requirements must be supplied by the manufacturer, together with copy of approved testing laboratory report and samples for tests and shall be subject to the approval of the Contracting Officer.

The architect specifying liquid bonding agents must familiarize himself with the over-all physical properties of such materials. Recognized manufacturers of such materials are able to furnish performance data which indicate bond strengths for various types of surfacing materials.

For example, one manufacturer lists various strengths, in psi, for bonding plaster materials to concrete surfaces:

1:3 Ottawa Sand Mortar	367
1:3 Brown Coat (Gypsum)	138
Acoustical Plaster	68
1:3 Perlite Plaster	167
Finish plaster	120

A military specification has been established for bonding compounds and concrete. This very detailed specification sets forth performance requirements:

	Tensile Strength
1:3 Brown Coat	60
Acoustical Plaster	65
Finish Plaster (30% gaging, 70% lime plaster)	120
1:3 Perlite Plaster	150
1:3 Ottawa Sand Mortar	200
1:3 Cowbay Sand Mortar	200
Neat Molding Plaster	250
Neat Portland Cement	250
Shear Strength	
Neat Portland Cement	300

GSA Standard Specifications

The largest federal government agency supervising building construction, the General Services Administration, has provided the following standard specifications for bonding agents:

> Bond adhesive for use on concrete walls shall be an aqueous resin emulsion, factory prepared for permanently bonding plaster to damp or dry concrete surfaces and tinted to show by visual inspection where it has been applied. It shall be vermin-proof, non-toxic, highly resistant to acids, not affected by alkalies present in concrete and plaster mixes, non-inflammable and shall not support combustion.
>
> It shall dry to touch on concrete in less than one hour, remain flexible when dry, develop a minimum bond strength of 150 pounds per square inch and have a performance temperature range of from minus 35°F. to 275°F. without bond failure. A certificate of compliance with this specification, signed by the manufacturer and endorsed by the Contractor, shall be furnished in duplicate to the Construction Engineer.

In addition, several large cities have, through their building standards' boards, approved certain manufacturer's bonding agents for specified uses. For example, New York and Los Angeles have tested and approved these bonding materials. One large manufacturer claims that 21 million square feet of plaster has been programmed for installation.

These few facts will give you an idea of the extensive use that architects and contractors and developers have made of bonding agents in their construction of new buildings. Of course many owners will continue to specify types of construction for which they have a preference. However, we believe all architects, contractors, building owners or potential building owners should be made aware of the considerable economic advantage that may be obtained in taking into account modern bonding agents in the planning, design and construction of their buildings.

New Bonding Techniques Stressed at S. A. E. Symposium in Detroit

A feature of the Combined National Automobile and Production Meetings of the Society of Automotive Engineers held the week of March 13 to 17 at the Sheraton-Cadillac Hotel, Detroit, Mich., was a symposium on "New Bonding Techniques—Their Effect on Future Design." Held on March 16, the symposium djscussed the progress which has been made in the development of new bonding methods and how these methods are likely to affect future product design. New adhesives and sandwich construction were included in the subjects discussed.

The session was chaired by A. F. Martin, research manager of the Adhesives, Coatings and Sealers Division of the Minnesota Mining & Manufacturing Co., and featured talks by four leading industry representatives.

A. F. Martin

Bonding Methods Reviewed

In his paper on the "Bonding of Structural Adhesives," E. J. Sydor, chief engineer of the Cycleweld Chemical Products Division, Chrysler Corp., reviewed a few of the more prominent types of structural adhesives and bonding methods and indicated where advances can be made in the immediate future. He pointed to the fact that there is every reason to believe that the use of structural adhesives will continue to grow because of certain well-defined advantages over other joining methods. Not only does the structural adhesive join the two pieces, but it also provides a continuous seal between them, giving a certain measure of vibration dampening.

The continuous seal of a non-conductive material practically eliminates the possibility of bi-metallic corrosion. The joints formed are smooth and protrusion free, and in certain materials such as glass or aluminum, bonding can be readily accomplished where it is difficult or impossible with other methods. Further, the load is distributed over the entire bonded area permitting the designer to use thinner sections and providing superior fatigue resistance, he declared.

It should be emphasized that adhesive bonding at the present time has certain limitations and cannot be indiscriminately applied to the joining of all parts. For many of them, it is essential that there be a controlled application of heat and pressure for a specified period of time. All of them have limited temperature stability and durability under severe environmental conditions. However, the practicality of the system has been effectively demonstrated in many applications and the use of structural adhesive joining methods will continue to grow as advances are made in adhesives and methods.

Processing Requirements

With regard to the present manufacturing operations, Mr. Sydor observed that processing requirements inherent in the present impact-resistant, structural adhesives prevent many potential applications from becoming production realities. With respect to the nitrile-phenolics, the unrefrigerated shelf life of two to six months and the flammability and toxicity of the solvents involved have prevented many manufacturers from evaluating this material in spite of the many other advantages.

E. J. Sydor

S. J. Dastin

M. E. Lerner

Compounded latex systems have been tried in many applications, but the results have been disappointing because of low strengths, especially at high temperatures. It is Mr. Sydor's opinion that major advances will be made in the immediate future to overcome many of the objections relating to the storage and application of nitrile-phenolic liquid cements.

New Techniques Sought

Another paper presented at the symposium was entitled "New Techniques in Bonding Solid Rocket Fuel Motor Cases" by Samuel J. Dastin and Philip Rosenberg of the Manufacturing Research and Product Department of the Republic Aviation Corp., Farmingdale, L.I. Presented by Mr. Dastin, this paper noted that government agencies and industries are presently in search of new approaches to lightweight, high-strength solid rocket motor cases. Republic Aviation has been investigating the suitability of high-strength steel bonded cases based on metal design allowables up to 350,000 psi. To accomplish this end, various structural adhesives were evaluated, process techniques were developed, and motor case scale models were constructed and tested.

Tests have shown that conventional adhesives can function in a solid rocket motor case in which the metal adherent is stressed to 250,000 psi. To improve this value even further, the adhesive should be designed so that its shear modulus varies along the bonded joint. A varying shear modulus adhesive was prepared and tested on a 6-inch overlap and compared to a constant shear modulus adhesive. The former showed, at failure, a 25 per cent higher load carrying capability under similar conditions of test, the speaker said.

Mr. Dastin observed that the Republic bonded rocket motor case was the result of a number of studies on adhesive design analysis. Early tests showed the importance of high-shear flexible bonding agents. A rigid liquid epoxy adhesive was tested on long lap tensile shear specimens and then chemically modified for increased flexibility and retested. The results indicate a maximum load-carrying capability at the 40 per cent flexibility point. Further flexibility lowers the allowables, since the inherent high shear capability of the rigid epoxy is reduced by flexibilization.

Stress and Strain Study

These data led to a detailed mathematical study of the incremental stresses and strains within the adhesives. The shear stress distribution within the joint is the controlling factor on long lap bonds and its effects have been practically ignored by the adhesives industry, as a result of standardized short lap adhesive qualification tests, Mr. Dastin noted.

Further testing has shown that an adhesive would possess superior load-carrying capability if its shear modulus could vary within the joint, with a maximum at the center of the joint gradually reduced toward the ends. This would allow for the greater elongations at the ends of the joint under load.

Republic Aviation Corp. has defined such an adhesive as a "composite adhesive." When thoroughly evaluated, the composite adhesive concept will provide designers the tool with which to create the hardware previously considered to be unattainable. Design safety factors will be based on metal ultimate allowables rather than yield allowables, and thereby result in significant weight reduction, he said.

Future of Bonding

Compound structures of dissimilar metals adhesively joined will provide structures with greater versatility at lower cost. Large prototype structures and design changes can be quickly produced without the need for costly and complicated tooling required for conventional joining techniques.

It is anticipated, he declared, that the future of adhesive bonding lies not only in military structures, but also in such commercial structures as buildings, homes, automobiles, and ships. The extent to which adhesives can be used in these fields is dependent on the imagination and daring of the designer, Mr. Dastin concluded.

For his part in the symposium, M. E. Lerner, publisher of ADHESIVES AGE, discussed "The Impact of Adhesives on Design." Mr. Lerner devoted the first portion of his paper to a discussion of joint design. He pointed out that the successful application of adhe-

sives is dependent upon the proper design of joints and noted that it must be kept in mind that an adhesive-bonded joint derives its strength by utilizing a larger contact area than joints of other types.

Consequently, the greatest strength is obtained in, for example, a metal-to-metal application if the maximum amount of bonded area is put to work. Therefore, the first fundamental for the effective uses of adhesives is to plan all metal joints with a geometrical configuration that is most favorable to maximum strength. Furthermore, Mr. Lerner declared, it should be remembered that adhesives seldom display their best properties when substituted directly for other types of fastenings.

The speaker stated that designers and engineers must recognize the important differences between a joint suitable for adhesive bonding and one suited for welding, brazing or similar fastening methods.

Greater Adhesive Use

Mr. Lerner then went on to speak of other matters, particularly the forces working toward the greater use of adhesives in the years ahead. He noted that there is a psychological factor in the mind of many consumers that inhibits increasing use of adhesives because many consumers automatically assume that mechanical fastening methods are "better" than chemical fastening.

The solution, he stated, rests with all of us. The educational campaigns which business papers can sponsor and the literature which individual companies disseminate all contribute as does the approach taken in advertising.

As to the factors which are contributing to the greater use of adhesives, Mr. Lerner cited the fact that adhesives lend themselves to automation. This means greater productivity per man hour and lower labor costs. Prefabrication is another area pointing to increasing use of adhesives.

The speaker noted that the most complete scrutiny of any assembly problem will sooner or later involve the use of adhesives. Without being overly dramatic, he said, "one cannot but be impressed with the production efficiencies which the proper use of adhesives will bring."

I. E. Poston

Mr. Lerner concluded his presentation by offering a number of case histories in which the design function was enhanced through the use of adhesives. Included were sails which were bonded rather than sewn; aluminum cooling coils in home freezers which were bonded rather than brazed; the use of tapes in building panels where screws formerly were employed; the use of adhesives to bond small pinion gears where brazing had previously been employed; a modular packaging system which is assembled by adhesives; new architectural designs employing glue-laminated wood arches, and the assembly of pumps by adhesives.

Application Equipment

The speaker also touched upon the lacks which exist in adhesives equipment. He noted that the design and manufacture of adhesive application equipment uniquely suited to the needs of adhesives consumers will open new markets for equipment producers, take full advantage of the properties of the adhesive and provide the consumer with new efficiency and economy in his operation.

The fourth paper at the symposium was presented by I. E. Poston of General Motors Manufacturing Development. Mr. Poston's paper was co-authored by K. D. Downing, Sr. and K. J. Mack, and considered the subject, "The Glue Line—Why, How and When."

Develops Resin System

Union Carbide Plastics Co. a division of Union Carbide Corp., New York, N.Y., has developed a waterborne, non-flammable resin, Bakelite phenolic resin BRL-5009, and a hardener, Bakelite phenolic hardener BRP-0314, which, when combined, produce both hot and warm coated sands for shell molds and cores. The combination can be processed in a variety of sand mullers with hot air supply and can also be used with pre-heated sand. According to Union Carbide, shell molds and cores made with BRL-5009/BRP-0314 coated sand have excellent strength and hot rigidity characteristics which produce shells and cores with good thermal shock resistance. In addition, the company states, there is no shell cracking, peel-back, or hot tearing of castings. Short dwell and curing times, fast bond, good surface finish, dimensional stability and tolerance control and, in some applications elimination of machining and drill operations, are additional advantages claimed for the resin-hardener.

Adhesive Council Seminar

The Rubber & Plastic Adhesive and Sealant Manufacturers Council featured a special seminar on "Financial Control and Planning" at its meeting on March 22 to 24 at the Hollywood Roosevelt Hotel, Hollywood, Calif. Francis M. Jeffe (Pierce & Stevens Chemical), Adhesive Council treasurer, acted as general chairman of the seminar. The topics and speakers were:

"Planning, Controlling and Forecasting in a Corporate Division", by Robert L. Krentler (Chrysler); "Costing an Adhesive", by Earl W. Sockel (Goodrich) and John Delmonte (Furane Plastics); "Inventory Control", by D. G. Williamson (Williamson Adhesives), Paul Cooper (Coast Pro-Seal), and J. S. Ross (Permalastic); "Order Processing", by Robert M. Godley (Miracle Adhesives), and Ralph C. Theiss (Battenfeld Grease & Oil); "Budgeting, General, Administrative and Research", by Lloyd L. Cooper (Products Research), and Bernard R. Hodowski (Caram).

New Monomers Available

Two new compounds designed for use as functional group monomers in the production of various copolymers, and as chemical intermediates, have been developed by Rohm & Haas Co., Philadelphia, Penna. The new compounds, 2-hydroxyethyl methacrylate (HEMA) and 2-hydroxypropyl methacrylate (HPMA), are reported to be of particular interest in the production of thermoset acrylic coatings. The new functional group monomers can be polymerized in solution or emulsion with a variety of monomers to give copolymers containing reactive hydroxyl groups. These pendant hydroxyl groups can then be reacted with OH-reactive bifunctional chemicals to form thermosetting plastics and elastomers. Additional uses of the compounds are in wool stabilization formulations, binders for non-woven fabrics, and in other polymeric products.

Celanese Chemical Plant

A new chemical plant, estimated to cost about $12 million, will be erected by Celanese Chemicals Division, Celanese Corp. of America, at a site in Bay City, Texas. The unit will produce about 100 million pounds of acetaldehyde and 2-ethyl hexanol annually. Both of these chemicals are used in a wide range of adhesives, plastics, and other products. When completed, by mid-1962, the new facility will boost the productive capacity of Celanese Chemicals to more than one billion pounds of chemicals annually.

Record Sales at Borden

Earnings in 1960 for the Borden Co. rose to a new high for the fifth successive year, with sales also setting a new record. Earnings of $26,856,250 for 1960 represent a 5.1 per cent increase from the 1959 figure of $25,548,693. This is the equivalent of $2.71 per share on 9,907,700 shares outstanding, as against $2.61 a share in 1959 on 9,800,000 shares outstanding. Sales totaled $956,014,030, a 1.6 per cent increase from the $941,326,495 high record in 1959.

W. R. Bradshaw

Sees New Epoxy Uses

Speaking at a meeting of the Downtown Exchange Club of Houston on February 9, W. R. Bradshaw, president of Bradco Plastics, Inc., Houston, Tex., predicted that epoxy resins will be used more extensively than ever before in the petroleum field. "In the next ten year", he declared, "more and more demands will be placed on the epoxies as means of finding short-cuts in both the production and transmission of oil and gas."

Although epoxies are best known in the petroleum industry as internal coatings for gas transmission lines, Mr. Bradshaw pointed out that they are also beginning to prove themselves by solving the small problems that arise in day-to-day operations in the fields. He cited, as an example, the use of an epoxy putty to seal a break in the cement jacket which covered an underwater pipeline. The cement covering had been placed around the pipe to provide corrosion protection and furnish proper weighting in the water.

Epoxy-based materials have been used on offshore installations for coating platform pilings at points where the tide level accelerates rust damage. In addition, epoxy adhesives have been used in place of welding wear plates on gas pipelines.

● The Borden Co., New York, N.Y., has acquired the Hawley-Monk Co., Cincinnati, Ohio, manufacturer of inks, varnishes and related materials for the graphic arts industry.

Ebers and Marusi Elected at Monochem

Earle S. Ebers, a group vice-president of the U.S. Rubber Co., has been elected president of Monochem, Inc., and Augustine R. Marusi, president of the Borden Chemical Co., has been elected executive vice-president of the recently-formed chemical company which is jointly-owned by Borden and U.S. Rubber. The formal organization of Monochem calls for the annual rotation of the presidency and vice-presidency between the joint owners. Other officers of Monochem are: John V. Lynn, vice-president of operations; Everett L. Noetzel, treasurer; and Granville T. Pownall, secretary.

Representing Borden on Monochem's eight-man board of directors are: Eugene J. Sullivan, William R. Moffitt, and Messrs. Marusi and Noetzel. The U.S. Rubber members are: Herbert M. Kelton, F. Dudley Chittenden, F. N. Taff, and Mr. Ebers.

Monochem has begun construction of a $20 million chemical plant at Geismar, La., the first unit in a major chemical complex planned for the 850-acre site. According to the company, approximately 150 million pounds of vinyl chloride and 80 million pounds of acetylene will be produced annually, the output to be used by adjacent, individually-owned Borden and U.S. Rubber facilities for the manufacture of other chemical products.

Atlas Builds Polyols Unit

Atlas Powder Co. will construct a new plant on the site of its chemicals unit at Atlas Point, Del., which will produce 50 million pounds a year of glycerin and related polyols by a new, Atlas-developed process. Most of the initial output of the $17,000,000 facility will be sold on contract, or used by Atlas in its other operations. Glycerin, ethylene glycol and other glycols will be produced by the new process, which involves both hydrogenation and hydrogenolysis of carbohydrate raw materials. The facility is scheduled for completion by the second quarter of 1962.

MIT Offering Adhesives Course

Two special summer courses on adhesives and plastics are being offered by the Massachusetts Institute of Technology Plastics Research Laboratory, Cambridge, Mass. The session on "The Science of Adhesion" will be held from June 26 through June 30, and covers such topics as solid surfaces, application of adhesives, wetting, tackiness, preparation of solids for glueing, setting, types of adhesives, stresses in adhesive joints, nondestructive testing, destructive testing, adhesion in reinforced joints, and theory of adhesive joints.

"The Technology of Reinforced Plastics" session will be held on June 19 to June 23, and will cover such topics as influence of resin characteristics, glass-polymer interface reactions, electron microscope studies of finish agent deposition, long-time mechanical behavior, fundamental aspects of adhesion, shrinkage pressure effects in polymer-filament systems, test methods for filament-wound structures, optimization of structural sandwich design, architectural uses of reinforced plastics, mechanical test methods and properties, and continuous production of filament-wound articles.

Tuition for each course is $200. Additional information can be obtained from F. J. McGarry, Plastics Research Laboratory, Massachusetts Institute of Technology, Cambridge 39, Mass.

Reassign Representatives

Three sales representatives for the National Adhesives Division of National Starch and Chemical Corp. have been assigned to new territories. William A. Hanson, formerly in the New York district sales office, will relocate at Buffalo, N.Y. Ted A. Newman, formerly sales representative in New York and Baltimore, has been transferred to the Southeastern Division, and will be headquartered at the Atlanta, Ga. office. Lawrence Okun has been transferred from the New York sales district to the company's Baltimore, Md. office.

W. E. Fertig

Named Representative

Walter E. Fertig has been appointed district sales representative in northern California, Oregon, and Washington by Adhesive Engineering, San Carlos, Calif., a division of Hiller Aircraft Corp. Mr. Fertig was formerly associated with Coast Pro-Seal and Mfg. Co. as district manager, and has had broad experience in the sales of epoxy, polysulfide, and polyurethane compounds to the building and construction industry.

ASME Sponsoring Show

The Machine Design Division of the American Society of Mechanical Engineers is sponsoring an exposition and conference, the Design Engineering Show, to take place in Cobo Hall, Detroit, Mich., from May 22 to 25. Both the exhibits and conferences will be devoted to the research and development aspects of new products. Materials and component parts for all types of manufactured products will be shown. A number of conferences will be held for discussion of several aspects of design engineering. Show hours will be from noon to 5:30 p.m. daily, except Tuesday, when the exhibits will remain open until 10 p.m. Further details may be obtained from Clapp & Poliak, Inc., 341 Madison Ave., New York 17, N.Y.

Announce Licensing Policy

Pittsburgh Chemical Co., a subsidiary of Pittsburgh Coke and Chemical Co., Pittsburgh, Penna., and Shell Chemical Co., New York, N.Y., have reached a new agreement covering the licensing of epoxy resin/coal tar compositions using Epon resins. Formerly, Pittsburgh Coke and Chemical had granted Shell Chemical a license, under U.S. Patent No. 2,765,288, which allowed Shell to pass on royalty-free rights to all customers purchasing Shell's Epon resins who desired to produce these compositions for paving, surfacing, or sealing pedestrian and vehicular trafficways. Under the new arrangement, Shell Chemical has agreed to obtain written licensing agreements from all customers desiring royalty-free rights to use the Epon resin/coal tar combinations.

Named Sales Manager

Campbell Lewis Gardner has been appointed sales manager for Schenectady Varnish Canada, Ltd., Toronto, Ontario. He will direct and coordinate sales and marketing of Schenectady Varnish's products in the provinces of Ontario and Quebec. Mr. Gardner has been closely associated with the varnish and ink industries since his service with the RCAF during World War II. He joined Schenectady Varnish Canada in 1957 as a technical sales representative for the company's complete line of varnishes and resins.

Hercules Completes Unit

Newly-completed facilities of the Hercules Powder Co., Hercules, Calif., are now producing three urea-formaldehyde concentrates, UFC 7626, UFC 7147, and UFC 8545, differing only in the content of formaldehyde, urea, and solids. These first three products of an expected line of concentrates are designed for the production of urea-formaldehyde resins, needed by industries on the West Coast, for the manufacture of plywood adhesives, furniture, paper, particle board, textile and protective coatings. Hercules reports.

Let's Keep Rolling Ahead

We Americans invented mass production, then we *had* to build mass demand to keep the wheels turning. For this purpose we called upon advertising – the most effective and economical means of creating mass demand. Soon we had more jobs, higher incomes, and better living conditions. And there isn't any limit to how much farther we can go, if we just keep it rolling!

Plan Gordon Research Meeting on Adhesion

The Gordon Research Conference on Adhesion will be held from August 28 through September 1, 1961, at the New Hampton School, New Hampton, N.H. Ten papers will be presented, with Robert L. Patrick (Alpha R & D) serving as chairman, and F. H. Wetzel (Hercules Powder) as vice-chairman. The papers and their authors are:

August 28—"Bulk Properties of Polymers and Their Effect on Adhesion," by Turner Alfrey (Dow Chemical); "Bulk Properties of Metals and Their Effect on Adhesion," by Edward J. Ripling (Materials Research Laboratory).

August 29 — "Molecular Forces and Zero-Point Energies," by Peter Debye (Cornell University); "The Effect of Molecular Structure and Shape on Adhesion," by George G. Cocks (Battelle Memorial Institute).

August 30—"Rubber-Textile Adhesion," by William C. Wake (Rubber & Plastics Research Assoc. of Great Britain); "Fiber-Rubber Adhesion," a panel discussion, by H. T. Patterson (DuPont), M. W. Wilson (Goodrich), and F. N. Kelley (Institute of Rubber Research).

August 31—"Curing Mechanisms of Phenolic-Elastomer Blends," by G. R. Sprengling (Westinghouse); "Surface Analysis by Infrared — New Techniques," by Louis H. Sharpe (Bell Telephone); "Elastomeric Properties in Adhesion," by Charles F. Blaich (Carwin).

September 1—"Glass Flake Reinforcement and Flaw Theory," by Leonard Suffredini (Narmco Research).

Flexible Grout Available

A new grout for floors and counter-tops made of ceramic tile, quarry tile, mosaics, marble, slate, and other materials, is being offered by Buehler Brothers Co., Dover, Ohio. Called Flexgrout, the new product reportedly provides a flexible grout joint for these materials when installed on resilient sub-surfaces, such as plywood, with adhesives. The grout is said to remain flexible permanently, and is easy to maintain and clean.

Leo Middlebrook

Named by Kleen-Stik

Leo Middlebrook, formerly assistant to the president, has been named manager of the recently-formed Machinery Division of Kleen-Stik Products, Inc., Chicago, Ill. The new division was formed to handle the design, production, leasing, and sales of the Model 60 multi-tape applicator and the air-jet-operated Label-Aire applicator equipment.

Pres-Stix Names Two

Pres-Stix Tape Co., Port Huron, Mich., has named Donald B. Roberts and Martin Progeblin as regional managers for its southern and eastern areas. Mr. Roberts will head the southern area and be headquartered in St. Louis, Mo. Mr. Progeblin will direct the eastern area operations from New York City.

"Please don't let the name mislead you, because our prices are smack up to date!"

Fasson Names Five

Fasson Products, a division of Avery Adhesive Products, Inc., Painesville, Ohio, has appointed four new sales representatives and a new regional sales manager. Leon Kantey, a sales representative for Fasson Products since 1956, has been named manager of the Philadelphia sales district, and will direct sales activities for the division in Maryland, Delaware, Washington D.C., eastern Pennsylvania, and southern New Jersey.

Angelo A. Luciardi, formerly general manager of the Home Equipment Co., has been named sales representative for central California from the northern Los Angeles area to north of Fresno. Jack Duke, formerly sales representative for Diamond Match Co., becomes sales representative for northern California, Utah and Nevada. Robert V. Fahey, previously a sales representative for Reuben H. Donnelly, has been named sales representative for western Pennsylvania and West Virginia. William Hoffman, previously with National Art Crafts, will represent Fasson in southern Michigan, including Detroit.

Animal Glue Output

Total production of animal glue in January, 1961, totaled 8,999,000,000 pounds, according to the latest Census Bureau reports, compared with the record figure for January, 1960, of 9,231,000,000 pounds. The breakdown for January, 1961 shows that 4,740,000,000 pounds was reported as hide glue, and 4,259,000,000 was bone glue. Total output for the previous month was slightly lower, at 8,767,000,000 pounds.

Shipments of hide glue totaled 8,900,000,000 pounds, as against 7,657,000,000 pounds for the previous month, and 10,305,000,000 pounds shipped in January, 1960. Stocks of hide and bone glue totaled 37,444,000,000 pounds at the end of January, slightly above the level reported at the beginning of the month. For the same month last year, stocks were placed at 31,266,000,000 pounds.

3M Appoints Managers

Minnesota Mining & Manufacturing Co. has appointed new plant managers at its pressure-sensitive tape units in St. Paul, Minn., and Bristol, Penna. R. C. Bertelsen, previously superintendent of pressure-sensitive tape operations at the Hutchinson, Minn. plant of 3M, has been named manager of the company's St. Paul, Minn., unit. A. F. Jacobson, formerly manager of the pressure-sensitive tape plant in St. Paul, has been promoted to manager of the tape and adhesives, coatings and sealers unit in Bristol, Penna.

A graduate of the University of Minnesota with a B.A. in chemical engineering, Mr. Bertelsen joined 3M in 1948 in the tape laboratory. He transferred to the Hutchinson plant in 1953 as technical assistant to the plant manager, and became tape superintendent in 1957. Mr. Jacobson holds a B.A. degree in chemical engineering from Iowa State University. He joined the 3M tape laboratory in St. Paul in 1947, and from 1950 to 1952 served as assistant to the manager of the Hutchinson unit. He was technical assistant to the manager and tape production superintendent at the Bristol plant from 1952 to 1959, when he became tape plant manager at St. Paul.

Plastic Floor Patch Rolls

Ranco Industrial Products Corp., Cleveland, Ohio, has developed an improved floor patch material called Magic Floor, which is said to patch flooring within minutes without mixing, troweling, or drying time. The new product is designed for heavy duty industrial floors of concrete, wood, wood block, brick, and steel. The Magic Floor formulation contains "shatterproof aggregates" which reportedly increase the durability and resistance to shock and abrasion. The floor patch material is made in a fine grading which featheredges under heavy usage. It can be rolled down with a wide wheeled industrial lift truck, and will not stick to truck wheels.

O. W. O'Neill

Named Sales Supervisor

A. E. Staley Manufacturing Co., Decatur, Ill., has appointed Owen W. O'Neill as chemical sales supervisor. A graduate of the University of Illinois, Mr. O'Neill served three years as an officer in the U.S. Navy during World War II before joining Staley early in 1960 as a management trainee.

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ASTM C-24 Holds Executive Meeting

The Executive Committee of ASTM Committee C-24 on Joint Sealants met on March 9 at the offices of Skidmore, Owings & Merrill in New York City, to review the progress of its subcommittees, and to plan for participation in the Society's annual meeting. Henry Lipkind (Avadan Corp.), secretary of Subcommittee 1 on Nomenclature, was appointed chairman of the subcommittee, succeeding G. F. Lamb (Construction Specifications Institute).

Subcommittee 2 Activities

Frank L. Frybergh (Skidmore, Owings & Merrill), chairman of Subcommittee 2 on Bulk Compounds, reported on the activities of the subcommittee's three task groups. Task Group A on Tests for Adhesion in Tension and Accelerated Aging reported progress in the formulation and evaluation of such tests, but does not anticipate immediate definitive results.

Task Group B on Tests for Application Life, Rheology and Flow suggested that a more appropriate term for the interests of this group would be "Tests for Application Rate and Flow." It appears that a test method involving controlled extrusion versus time may prove to be most suitable for measuring application rate. For measuring flow, the currently recommended channel tests appear logical, but it is essential that the type and finish of metal used for the test channels be clearly defined. Recommendations on both of these subjects will be presented soon for consideration as tentative standards.

Staining Tests

Task Group C on Staining Tests reported that a round-robin evaluation of a Bureau of Standards Staining Test is being conducted, and indications are that this method may be faster and more reliable than that specified in ASA Specification A116.1. It appears likely that evaluation work may soon be completed, and that this test can be considered for approval as a recommended tentative standard.

R. W. McKinley (Pittsburgh Plate Glass), chairman of Subcommittee 3 on Preformed Shapes, gave a report on the subcommittee's plans and activities. A discussion was held on the paper "Study of Architectural Joint Problems", prepared by C. B. Monk, Jr., (Structural Clay Products Research), chairman of Task Group A, and it was considered that the paper would serve admirably as a guide for the work of the subcommittee.

M. F. Torrance (DuPont), secretary of Subcommittee 3, outlined plans for field tests of preformed gasket seals which will be undertaken by DuPont, and suggested that these might be planned so as to contribute to the work of the subcommittee. Mr. McKinley announced that a meeting of Subcommittee 3 will be scheduled shortly to establish a program for action on several projects.

June Meeting

The Executive Committee has decided that meetings of the three subcommittees and ASTM C-24 will be held on June 27, 1961 during the ASTM Annual Meeting at Atlantic City. The tentative schedule calls for Subcommittee 1 to meet at 9:00 a.m., Subcommittee 2 at 10:00 a.m., Subcommittee 3 at 1:00 p.m., and C-24 at 3:00 p.m.

OBITUARIES

Samuel R. Adamson

Samuel R. Adamson, midwest division manager, vice-president and director for Miracle Adhesives Corp., Bellmore, L.I., N.Y., died recently at his home after a short illness. He was 53 years old. A native of Chicago, Ill., Mr. Adamson had formerly been associated with International Plastics Co. as midwest manager and with Industrial Tape Corp. as Chicago manager. He became midwest divisional manager for the Cofax Co. prior to joining Miracle in 1947. Mr. Adamson leaves his widow and two children.

Pearl Plus Starch

National Starch & Chemical Corp., New York, N.Y., has introduced a new specialty starch for enzyme conversion called Pearl Plus. A new method of treatment utilized during its processing enhances the enzyme convertibility of the starch and provides an end product of high strength and excellent viscosity stability. The treatment is said to produce more rapid and uniform conversion, and is designed to stabilize and utilize the molecular fraction of the cornstarch (amylose) so that a more stable viscosity is obtained. Flow properties, filming characteristics and binding strength of the converted starch are also improved.

Chemists at National Starch report that Pearl Plus may be consistently converted to a more optimum point than would be possible with regular enzyme converting starches, thus making possible a starch of less molecular degradation that can be applied to the paper without operational limitations. Additional features of Pearl Plus are said to be higher quality in terms of pick strength, printability, smoothness, writing properties, oil holdout and internal strength factors.

Acrylic Resin Introduced

B. F. Goodrich Chemical Co., Cleveland, Ohio, has developed a new acrylic film-forming resin known as Carboset 511. The resin is a water solution of an acrylic polymer that dries at room temperature to a clear, tough, glossy, water-insoluble film. Carboset 511 is compatible with water dispersions of most polymers and, according to Goodrich Chemical, makes possible desirable modifications of dispersion and solution coating materials. Films of Carboset 511 adhere well to metal, glass, paper, and leather and to Mylar, polyethylene and vinyl films. Possible applications for the new resin are as a floor polish additive, as a clay binder in paper coatings, as a hair set component, and as a protection for highly polished metal sheets during shipment, the company reports.

Peak Air Reduction Sales

In its annual report for 1960, Air Reduction Co., Inc., reported a record sales high of $202,486,344, compared with the previous record of $200,603,636 in 1959. Net earnings in 1960 were $14,692,381, equal to $3.73 per share of common stock, as against $14,850,600, or $3.81 per share, for 1959. Capital expenditures for 1960 were $15,700,000, compared with the 1959 total of $31,100,000.

The company reports that the polyvinyl alcohol resin plant of Cumberland Chemical Corp., located at Calvert City, Ky., is nearing completion. Cumberland, a joint venture in which Air Reduction owns a 60 per cent interest and the Ruberoid Co. owns a 40 per cent interest, is conducting an intensive program on the development of new uses for Vinol, the trademark for its polyvinyl alcohol resin. This program is aimed at finding large volume uses in the fields of adhesives, textiles, films and paper coatings and sizings.

Late in 1960, Airco consolidated the Air Reduction Chemical Division, the Colton Chemical Division and the National Carbide Division into a single division known as the Air Reduction Chemical and Carbide Co. The integration was designed to provide increased effectiveness in the production and sales of calcium carbide, acetylene, and acetylene derivatives. A multi-million pound ester plant, a warehouse, and bulk storage tanks were added to Colton's existing installation at Elkton, Md. Another Colton unit, a resin polymerization plant, is nearing completion at City of Industry, Calif.

Carlson Appointed

Shawinigan Resins Corp., Springfield, Mass., has appointed Robert P. Carlson, formerly a member of the Sales Department, to the Technical Service Department, where he will be responsible for technical service on adhesives applications. Mr. Carlson received his A.B. degree in chemistry from Brown University in 1955, and an M.B.A. degree in industrial management from the University of Pennsylvania in 1958. He joined Shawinigan in 1959.

Nalco Markets Silica Sol

Nalcoag 1034A, a new acidic, high-purity colloidal dispersion of silica, is being marketed by Nalco Chemical Co., Chicago, Ill. The salt-free silica dispersion is miscible with a number of organic solvents and has a pH range of 2.6 to 3.6. Nalcoag 1034A is said to increase bonding strength of cements, form a protective film on metals, and increase fiber-to-fiber friction in textiles. It can be applied by spray, roller, dipping, wiping, or brush.

Fenwal Appoints Johnson

Fenwal, Inc., Ashland, Mass., has named Robert C. Johnson as sales manager of its Resin Systems Division. He will be responsible for all sales and marketing for the division's line of epoxy resin handling and packaging systems. Previously sales promotion supervisor at Fenwal, with duties which included sales training, Mr. Johnson has also served in the development and applications engineering groups, and on a variety of special assignments.

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Simplify Plywood Process

A research team at Georgia-Pacific Corp., Springfield, Ore., has developed a new method of making plywood that reduces the number of production steps from five to about two, thus bringing the manufacturing operation much closer to a continuous process. Ordinarily, plywood manufacturing requires peeling of the veneer, curing, cutting to size and repairing of defects, wet gluing, and pressing. With the new process, the green veneer is fed directly to a four-story press where dry glue is dumped on it. Then it is heat bonded, which simultaneously cures the green veneer and sets the glue.

In addition, the surfaces are covered with resin-impregnated paper, which cures to a hard plastic-like coating. This eliminates the sanding operation, provides a paint base, and eliminates grain rise and cracking. According to Georgia-Pacific, the product has all the qualities of premium plywood, yet can be made from lower-quality veneer.

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HPI Elects Officers

The Hardwood Plywood Institute elected new officers and directors at its 20th Annual Spring Meeting, held on March 9 at the Shoreham Hotel in Washington, D. C. The following officers and directors were elected: *President*, Robert J. Weber (Weber Veneer); *Vice-president*, French R. McKnight (McKnight Veneer); *Directors*, Carl D. Wheeler (Georgia-Pacific), Leonard W. Wilson (Standard Plywoods), Mark Warren (Commonwealth Plywood), Dan W. Tyler (Carolina Veneer), and George R. Thompson, (Algoma Plywood).

Directors who remain on the board to finish their terms of office are: M. C. McIver (Splicedwood); S. M. Nickey (Nickey Brothers); John M. Prince (Jones Veneer); Donald H. Gott (Weyerhaeuser); M. H. Speltz (Memphis Plywood); and Walter A. Stilley, Jr. (Stilley Plywood).

At the suggestion of the nominating committee, the HPI by-laws were amended to increase the number of the voting members of the board to 13, and to make former presidents of HPI, ex-officio members of the board to act in an advisory capacity.

Heyden Expands Line

Heyden Newport Chemical Corp., New York, will expand into the epoxy resins and plastics market with the introduction of a new product line—liquid and resinous curing agents for epoxy resins, and viscosity modifiers. The company anticipates that future products will be added to this line. The line will be produced at the new facilities of the Heyden Chemical Division in Garfield, N.J. Sampling distribution of the new materials is scheduled for the second quarter of this year.

Flintkote Promotes Evans

H. L. Evans, previously vice-president of manufacturing for the primary building products manufacturing division of the Flintkote Co., New York, N.Y. has been appointed vice-president of general manufacturing for the company. He will continue to serve as a director of the corporation.

Shawinigan Names Eight

Shawinigan Resins Corp., Springfield, Mass., has promoted three research section leaders to executive posts, and has raised five research group leaders to the rank of research section leader. Edward Lavin, research section leader since 1955, has been appointed director of applications research. Dr. Aubrey F. Price, previously with the Research Department of Shawinigan Chemicals, Ltd. (Montreal), and research section leader of Shawinigan Resins since 1955, becomes director of product research. Harold D. Weymouth, associated with the Shawinigan research staff since 1939, and section leader since 1955, has been named director of research administration and planning.

The following group leaders have been appointed research section leaders: Dr. Albert H. Markhart, who was appointed group leader in 1956; Leo J. Monaghan, research chemist at Shawinigan for eight years prior to his appointment as group leader in 1956; Dr. Ralph F. Nickerson, formerly with Monsanto Chemical Co., and group leader since 1956; Dr. Forrest H. Norris, research chemist for four years prior to his appointment in 1955 to the post of group leader; and Herbert Terry, group leader since 1955.

New Hercules Resin

A new synthetic resin, available from Hercules Powder Co., Wilmington, Del., is reported to be soluble in alcohol and in aqueous ammonia, exhibit a broad range of compatibilities, have a high softening point, and remain hard and friable at room temperature. Called Pentalyn 255, the new resin is said to exhibit broad compatibility with polystyrene, acrylic, PVA, polyethylene and copolymer emulsions, and other ingredients used in various compositions made from such emulsions. The resin is also said to add gloss, hardness and glow without loss of flexibility to such products as floor polish, sealing wax, paper coatings, leather finishes, latex and emulsion paints.

Plans New Methanol Unit

E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., will build a multi-million dollar methanol facility near Huron, Ohio, which will produce about 30 million gallons annually. Construction on the 600-acre tract will start the latter part of this year, with completion slated for late 1962 or early 1963. The proposed construction, however, is subject to approval by the Federal Power Commission of a pipe line extension to supply the plant with natural gas.

The new facility would be the first methanol plant in the Great Lakes area. One of the major uses for methanol is in the manufacture of formaldehyde, which is used in the manufacture of adhesives, resins, textile intermediates, and agricultural chemicals.

• The Chemical Division of International Latex Corp. has appointed The Horton-Earl Co., Minneapolis, Minn., as sales representative for Tylac latices in Minnesota.

METLBOND 406 is already well-known to the aircraft industry where it is now being used for bonding metal skins to airframes, skins to honeycomb structures, and for metal-to-metal applications where greater strengths were required than could be obtained by welding or riveting.

METLBOND 406 is now adapted for general industrial applications where high shear strength is required, and where economy must be maintained. METLBOND 406 can substantially reduce your fabrication costs. This outstanding new adhesive system is furnished in dry sheet form. Moderate pressure (25 psi) and medium heat (300°F) will activate METLBOND 406 and allow it to fuse, flow freely, and wet mating surfaces. It can obviate the necessity for screws, rivets, and spot welding.

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May 2-9. Sixth International Packaging Show, R. A. Exhibition Building, Amsterdam, The Netherlands.

May 3-13. U. S. World Trade Fair, New York Coliseum, New York, N.Y.

May 4-6. National Paper Box Manufacturers Association, Annual Convention, Washington, D.C.

May 7-10. American Institute of Chemical Engineers and the Chemical Engineering Division, Chemical Institute of Canada, Joint Meeting, Cleveland, Ohio.

May 8-9. Society of the Plastics Industry, 19th Annual Canadian Section Conference, Sheraton-Brock Hotel, Niagara Falls, Ontario, Canada.

May 8-10. Technical Association of the Pulp and Paper Industry, 12th Coating Conference, Statler Hilton Hotel, Buffalo, N.Y.

May 9-11. Materials Handling Institute, National Industrial Packaging & Handling Exposition, Philadelphia, Penna.

May 10-12. American Institute of Chemists, Statler Hilton Hotel, Washington, D.C.

May 10-12. American Society of Mechanical Engineers, Production Engineering Conference, Royal York Hotel, Toronto, Ontario, Canada.

May 11-13. American Institute of Industrial Engineers, 12th Annual National Conference and Convention, Sheraton Cadillac Hotel, Detroit, Mich.

May 14-16. National Fibre Can and Tube Association, 28th Annual Meeting, Francis Marion Hotel, Charleston, S.C.

May 15-17. Chemical Specialties Manufacturers Association, 47th Midyear Meeting, Drake Hotel, Chicago, Ill.

May 16-18. Building Research Institute, Spring Conferences, Shoreham Hotel, Washington, D.C.

May 17-18. Chemical Market Research Association, 21st Annual Meeting, Plaza Hotel, New York, N.Y.

May 22-25. American Society of Mechanical Engineers, Design Engineering Conference & Show, Cobo Hall, Detroit, Mich.

May 24-25. Commercial Chemical Development Association, Resort Meeting, Bedford Springs Hotel, Bedford Springs, Penna.

May 24-June 11. Construction Industries Exposition & Home Show, Los Angeles, Calif.

June 5-7. American Society for Quality Control, Annual Convention and Exhibition, Sheraton Hotel, Philadelphia, Penna.

June 5-8. Instrument Society of America, Instrument-Automation Conference & Exhibit, Royal York Hotel, Toronto, Ont., Can.

June 5-9. Society of the Plastics Industry, National Conference, Hotel Commodore, New York, N.Y.

June 7-9. Paper Industry Management Association, National Meeting, Robert Meyer Hotel, Jacksonville, Fla.

June 9-17. European Congress of Chemical Engineering and 13th Exhibition-Convention of Chemical Apparatus, Frankfurt, West Germany.

June 11-15. American Society of Mechanical Engineers, Summer-Annual Meeting, Statler Hilton Hotel, Los Angeles, Calif.

Portrait of

D. V. ROSATO

D. V. Rosato, assistant plant manager of Telecomputing Corp., Newton, Mass., has done important research and development work in the fields of adhesives, plastics, ceramics and specialty alloys. He recently published an important paper on the development of inorganic and ceramic adhesives for missiles and jets (*Adhesives Age*, December 1960).

Mr. Rosato's previous experience includes work as chief engineer and product manager of the Reinforced Plastics Dept., Raybestos-Manhattan, Inc. and development engineer and plastics technologist for the Bureau of Aeronautics. He has been responsible for the development of original polyester polymers, plastics-phenolics, silicones, and phenolic-silane. He designed the first structural composite plastic airplane wing and fuselage, and developed materials for Vanguard, Polaris, Jupiter, Terrier and Sidewinder.

A graduate of Drexel Institute of Technology, from which he received his BS in Mechanical Engineering, Mr. Rosato has also attended Yale University, the University of Pennsylvania and Massachusetts Institute of Technology. He is a member of the Society of Plastics Engineers, the American Society of Mechanical Engineers, and the American Society for Testing Materials.

W. Roy Elliott

Shawinigan President

W. Roy Elliot has been elected president and general manager of Shawinigan Resins Corp., Springfield, Mass. In addition, he was elected to the board of directors. Mr. Elliot, who had been vice-president and general manager, succeeds Robert K. Mueller who has been elected board chairman. In addition, William H. Bromley was elected vice-president — marketing and secretary of the corporation, and Alfred W. Long was elected vice-president — finance and planning and treasurer. At the same time the appointment of two other vice-presidents was made known. They are Dr. Robert N. Crozier, vice-president — research and John C. Kenny, vice-president — production and engineering.

3M in Colombia

Minnesota Mining & Manufacturing Co., St. Paul, Minn., has formed a manufacturing subsidiary and acquired production facilities in Bogota, Colombia. The new South American subsidiary, called Minnesota Manufacturer y Mercantil, S.A., is presently modifying its facilities and production of Scotch brand pressure-sensitive tapes, adhesives, coatings, and sealers is expected to get underway by the end of 1961. Manuel J. Montiero, staff representative for South America from the 3M International Division headquarters in St. Paul, has been named general manager of the Colombia subsidiary.

Union Paste Names Three

Union Paste Co., Boston, Mass., has announced three new appointments. Howard H. Cutts, formerly territory manager, has been appointed technical director. Walter J. Zmijewski, formerly associated with LePages Glue Co., has been named assistant technical director, while Richard C. Valcovic, formerly territory manager in Pennsylvania, has been named advertising and sales promotion manager. Mr. Cutts graduated from Northeastern University with a B. S. degree. He joined Union Paste as a chemist in 1944, and was named a territory manager in 1948.

Mr. Zmijewski holds a B.S. degree in chemical engineering from Northeastern University. He joined the company in 1957. Mr. Valcovic attended Union College and Bentley School of Accounting. He was associated with General Electric prior to joining Union Paste in 1949 in the Customer Service Department. He was named territory manager in 1959.

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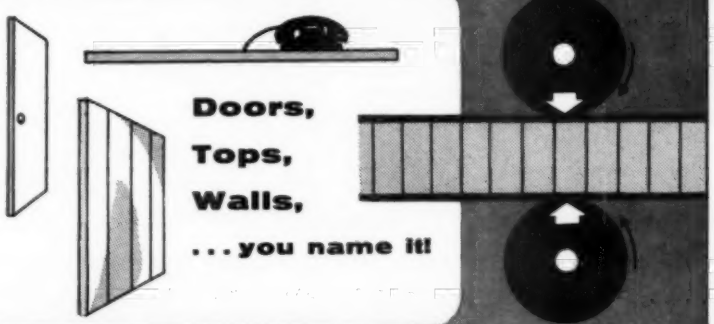

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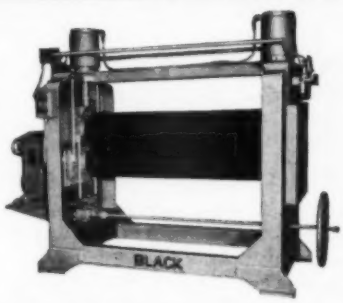

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names in the news

Irving Kramer, formerly general sales manager of Synthetic Fabrics, Inc., New York, N.Y., has been named vice-president of sales for the company.

Frederick W. Bradley, manager of the New England Division of the National Starch & Chemical Corp., has been named vice-president of the National College Program, Inc., which is engaged in the development and marketing of programs for financing college educations through banks.

William T. Cave has been named assistant director for analytical chemistry at the St. Louis, Mo., research center of Monsanto Chemical Company.

C. L. Michaud, formerly associated with Celanese Corp. of America, has joiner Polymer Industries, Inc., Springdale, Conn.

J. W. Hill has joined the research and development staff of Hysol Corp., Olean, N.Y., while *William I. Childs*, formerly with Dow Chemical Co., has joined the firm as a product development engineer.

Owen W. O'Neill has been appointed chemical sales supervisor of A. E. Staley Manufacturing Co., Decatur, Ill., while *Milutin Simic* has been named research chemist.

Dr. Harry Gehman, formerly assistant director of research, has been promoted to director of research at the George M. Moffett Laboratories of Corn Products Co., Argo, Ill.

J. M. Martin has been appointed sales manager of vinyl resins for Escambia Chemical Co., New York, N.Y., while *J. T. Carley* has been named representative for New England and metropolitan New York.

Dr. Morton W. Leeds has been appointed assistant director of research in the Chemical Division at the central research laboratories of the Air Reduction Co., Murray Hill, New Jersey.

Louis E. Georgevits has been named manager of technical sales to the paper industry for the Thermoplastics Division of the Borden Chemical Co., New York, N.Y.

Roger J. Mauterer has been named chief chemical engineer for A. E. Staley Manufacturing Co., Decatur, Ill., succeeding *Nat Kessler*, who has been appointed director of process engineering.

William J. Davis, formerly general sales manager of the Foam Division of the Scott Paper Co., has joined Permacel, New Brunswick, N.J., as merchandising director.

Leonard J. Malin, formerly on the engineering staffs of Servomechanisms, Inc., and Northrup Aircraft Co., has joined the Chem Seal Corp. of America, Los Angeles, Calif., as plant manager.

Gaylord M. Simpson has joined the staff of the Dow Chemical Co. analytical laboratories, Midland, Mich., as chemist.

James C. Smith, Jr., formerly chief chemist at Chase Bag Co., has joined Foster D. Snell, Inc., New York, N.Y., as chemist.

R. Jennings Byran, Jr. and *Dr. Loyd G. Kasbo* have joined the Chemstrand Research Center, Durham, N.C., as research chemists.

William E. Lowery has joined the Applied Plastics Division of Hexcel Products, Inc., Berkeley, Calif., as a technical representative in charge of urethane rigid foam materials.

John N. Gammon, formerly southern district sales manager, has been appointed vice-president in charge of sales for the Industrial Division of Nopco Chemical Co., Newark, New Jersey.

F. H. Werling, vice-president of Kimberly-Clark Corp., Neenah, Wisconsin, has been named chairman of the Wisconsin Committee of American Forest Products Industries for 1961.

Dr. W. L. Riedeman has been named supervisor of the Organic and Polymer Department at the research and development center of Food Machinery & Chemical Co., San Jose, California.

D. R. Patterson, formerly research chemist at the Emeryville, Calif., research center of Shell Development Co., has joined the New Jersey technical service laboratory of Shell Chemical Corp.

Dr. Raymond L. Mayhew has been appointed manager of technical service and development at the Antara Chemicals Division of General Aniline and Film Corp., New York, New York.

George C. Rayner has been named assistant to the president of the General Chemical Division of Allied Chemical Corp., New York, N.Y. *Actor H. Patton* has been named director of product development for the division.

Dr. M. Michael Shahin and *Dr. Peter D. Edwards* have joined the Research and Development Division of the Polychemicals Department of E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

Dr. Leslie J. Tyler, formerly supervisor of resin research, has been named assistant director of research at Dow Corning Corp., Midland, Michigan.

Melvin W. Searls, supervisor of the Insulrock Division of the Flintkote Co., New York, N.Y., has also been appointed to the newly-created post of merchandising director of the company's Building Products Div.

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patent review

By MELVIN NORD

Cohesive Bonds Between Sheets

U.S. Patent 2,962,404 issued November 29, 1960 to James W. McIntyre and John F. Hechtman, assigned to Kimberly-Clark Corp., relates to the production of cohesive bonds between two separate sheets, or two plies of a single sheet. The cohesive substance is so applied that the sheet or sheets may be interleaved or wound up into a package or packages without the necessity of including an additional sheet of parting material between contiguous plies or turns.

The invention is based upon the discovery that a suitable coating of an aqueous dispersion of colloidal silica which has been applied to the surface of a base sheet and then dried, activates the surface of the sheet by imparting to it certain valuable properties which have not been heretofore suspected or recognized. Among other properties the dry silica film on the sheet is found to be an excellent anchorage to which a suitable film of cohesive rubber or similar cohesive material may be subsequently applied and dried so as to form a sheet. It has a cohesive side which cannot only be permanently pressure bonded to itself, but, the plies of the bond so formed can later be separated manually without rupturing the base-sheet or damaging the cohesive film thereon.

In Figure 1, 10 represents a roll of untreated base-sheet, for example, glassine. The numeral 11 represents as a whole the coating equipment which consists of an applicator roll (12) and a lower roll (13), forming a nip through which the base-sheet (14) is propelled. An aqueous dispersion of colloidal silica is fed to a metering nip (15) between the applicator roll (12) and the metering roll (16). After leaving the metering nip, the coating which passes through the nip is divided, a part being applied to the applicator roll and a part being returned to the pool in the trough (17).

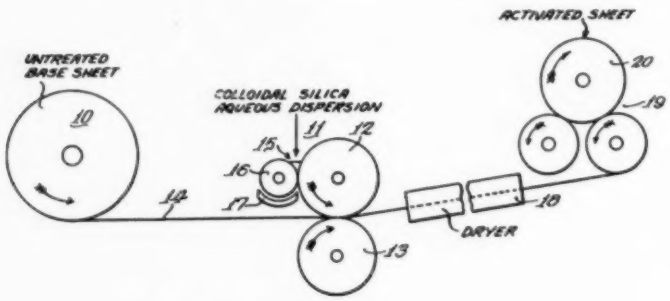


Figure 1

The concentration of the colloidal silica dispersion which is supplied to the coating equipment (17), and the pressure applied between the metering roll (16) and the applicator roll (12), are so adjusted as to supply the desired amount of colloidal silica to the surface of the sheet (14). After the sheet has passed through the applicator nip between rolls 12 and 13, it is conducted through a dryer (18) and then by means of the rewinder (19) it is wound into a roll (20). The pre-coated or activated surface of the sheet is on the outside of the roll (20).

The activated surface of the sheet of the roll (20) is then coated with cohesive rubber by the coater (21) shown in Figure 2. In view of the fact that the activated or pre-coated surface of the sheet is on the underside as it travels to the coating rolls, the applicator roll (22) is located below the complementary roll (23) which, with the applicator roll (22) forms the nip through which the activated sheet (24) is propelled. The aqueous rubber dispersion (25) is metered by a metering roll (26) which contacts the lower face of the roll (22).

The cohesive rubber aqueous dispersion which is fed into the pool (27) is of such concentration and the metering pressure between rolls 26 and 22 is such that sufficient rubber is applied to the sheet to increase the dry weight of the sheet to the extent of about .20 to 1.3 pounds per 1000 square feet of sheet.

After the sheet has received its

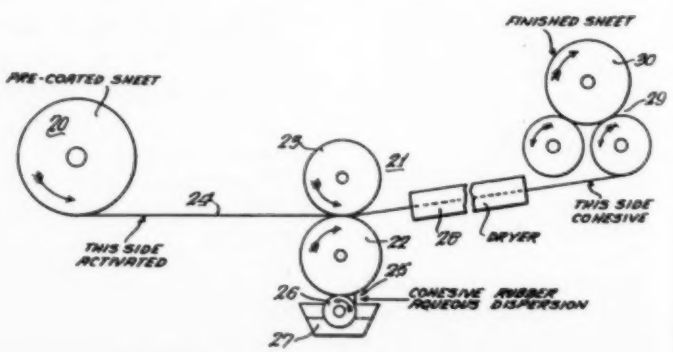


Figure 2

rubber coating, it is then conducted through a dryer (28) to remove excess moisture, and is then rolled up in a rewinding device (29) to form a completed roll (30) of finished material ready for immediate use. If the finished material is to be stored for future use, it is advisable to include a suitable antioxidant in the cohesive dispersion.

Liquid Adhesive Applicator

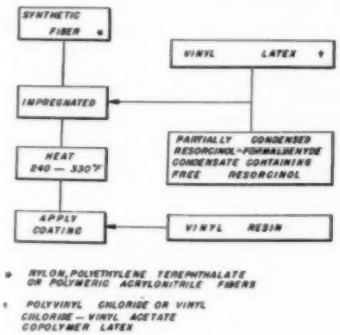
U. S. Patent 2,965,068, issued December 20, 1960, to John A. Pharris and George E. McGuire and assigned to the E Z Paintr Corp., provides an apparatus for applying liquid adhesive to an advancing and rotating continuous cylinder, in order that a cover material may be adhered to the cylinder surface (e.g. for paint roller covers or the like).

The adhesive applicator functions by moving the entire continuously advancing and rotating core bodily through an open passage which is in direct communication with the bottom of an adhesive pot, so that the core essentially passes through an adhesive bath and acts as the only seal for preventing adhesive escaping from the bath. At the entrance side of the bath the core passes through a close fitting sealing ring, while at the exit side it passes through a serrated extruding die which leaves an uneven layer of adhesive upon the core. The extruding die is rotated at the same rate as the advancing and rotating core, so that the adhesive surface is striated longitudinally with respect to the core.

In order to accommodate the extruding die to variations in core diameter due to irregularities in manufacture, the die consists of a number of radially movable die segments which are spring-urged into engagement with the cylinder or core surface. Preferably the extruding die segments are individually mounted and urged by individual springs, to compensate for lack of perfect roundness of the cylinder or for variations in the die structures. It is also preferred to smooth out the adhesive surface with suitable brushes.

Vinyl Resins to Nylon

U.S. Patent 2,961,343, issued November 22, 1960 to Everett C. Atwell and assigned to Burlington Industries, Inc., relates to the adhesion of vinyl resins to nylon or other synthetic fibrous materials.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VINYL RESIN
* NYLON, POLYETHYLENE TEREPHTHALATE OR POLYMERIC ACRYLONITRILE FIBERS
† POLYVINYL CHLORIDE OR VINYL CHLORIDE — VINYL ACETATE COPOLYMER LATEX

The method involves the preparation of an adhesive on the synthetic fiber, after which the vinyl resin coating may be applied.

Glue Mix

U.S. Patent 2,963,454, issued December 6, 1960 to Carl E. Drugge and John M. Hine and assigned to The Borden Co., discloses an adhesive consisting of 100 parts of soya bean protein, 11.9-189.7 parts of an aqueous emulsion of polyvinyl acetate, water, and 4-60 parts of sodium hydroxide. The alkali is present in an amount sufficient to cause the protein to become soluble and dissolve in the water in the mixture.

Bonded Abrasives

U.S. Patent 2,965,464, issued December 20, 1960 to Walter E. F. Rupprecht and assigned to The Dow Chemical Co., provides compositions for use in preparing bonded abrasive articles consisting of an abrasive grain, a permanent binder which is thermally insensitive at the temperature of combustion of the temporary binder, and five to 15 per cent by weight of the temporary binder.

The temporary binder consists of a blend of polymer latices in about equal weights polymeric solids. One of the latices is the emulsion polymerizate of a vinylidene chloride-vinyl chloride comonomeric mixture. The other latex is the emulsion polymerizate of a styrene-butadiene comonomeric mixture.

Wood Adhesive

U.S. Patent 2,967,836, issued January 10, 1961 to William R. Moffitt and Morris B. Berkey, assigned to The Borden Co., provides an adhesive containing phenol-formaldehyde and a water-dispersible gum, *e.g.*, locust bean, karaya, or guar gum.

The gum serves to decrease the penetration of the adhesive composition when applied to wood, to increase the permissible assembly time with the adhesive, and to decrease the time required for curing at elevated temperatures.

Other Patents of Interest

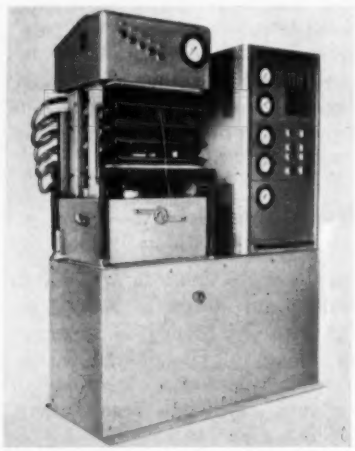
Subject	Inventor or Assignee	Patent No.	Date
Self-adhesive label holder	Coleman R. Chamberlin	2,964,866	12/20/60
Dispenser pack of individual adhesive bandages	Johnson & Johnson	2,965,223	12/20/60
Process for sizing paper	Corn Products Co.	2,965,518	12/20/60
Pressure-sensitive tape adhesives	Minnesota Mining & Mfg. Co.	2,965,592	12/20/60
Preparation of starch ethers	Corn Products Co.	2,965,632	12/20/60
Apparatus for cutting tacky material	Western Electric Co., Inc.	2,966,085	12/27/60
Manufacture of starch products	Naamloze Vennootschap W. A. Scholten's Chemische Fabrieken	2,967,110	1/3/61
Producing gelling starch of high clarity	Corn Products Co.	2,967,178	1/3/61
Labeling machine	M.R.M. Machinery Co., Inc.	2,967,636	1/10/61

Copies of any patents, including those described here, are available from the Commissioner of Patents, Washington 25, D.C., for 25 cents each. Do not send stamps.

new equipment

Hydraulic Laminating Press

A hydraulic press, consisting of the press frame and platens, motorized hydraulic unit, and control panel, is being offered which produces laminations of a variety of materials. There are five 19 by 19-



inch electrically heated and water-cooled platens. The force the press exerts may be varied from zero to 75 tons by adjusting a handwheel located below the press frame. The motorized unit is controlled by push buttons located on the control platen. Platen closing and opening, the application of platen pressure, and the amount of time needed for platen heating and water cooling are all controlled by a sequence timer.

The operator inserts the items to be laminated between the platens, presets the sequence timer, and presses a button to begin press operation. At the end of the operation, the platens open to permit removal of the laminated objects. The press can also be operated without the timer, so that each operation can be controlled independently. Platen heating can be adjusted to 600° F., and the heat can be cut off any platen by means of individual toggle switches. *Kingsbacher Murphy Co.* **E-307**

Molecular Model Set

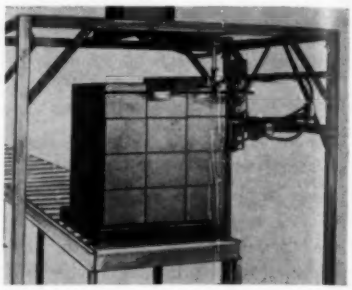
A new molecular model kit has been announced which gives researchers a more precise picture of stereochemical relationships. The basic units of the new model are a series of colored neoprene balls with threaded aluminum inserts molded into them. The inserts are accurately placed at the theoretical bond angles, while the elastic nature of the neoprene automatically distributes strain to all the bond angles involved. The molded atoms represent tetracovalent carbon, double bond, carbonyl or aromatic carbon, acetylenic, nitrile or allenic carbon, nitrogen, aromatic nitrogen, oxygen, and sulfur. There is also an octahedral atom for complex and inorganic use. Monovalent atoms are made of a rigid polystyrene, color-coded to indicate the element and bond length. The scale used in the design of the atoms and bonds is based on a factor of five centimeters per Angstrom. The complete kit includes 59 flexible neoprene atoms and 55 rigid polystyrene monovalent atoms, plus the true-to-scale bonds and fittings. Bond linkage permits either rotating or rigid connections, permitting conformational study. *Central Scientific Co.* **E-308**

Chemical Proportioning Pumps

A new series of small-volume, high-pressure, chemical proportioning pumps is available for cases in which small volumes of fluid must be handled at pressures up to 30,000 psi. Simplex or duplex models provide a choice of pressures from 7,500 to 30,000 psi., and have capacities ranging from 0.84 to 6.44 gal/hr. The pumps are said to feature an adjustable stroke length which completely evacuates the cylinder and permits efficient pumping of compressible liquids. *American Instrument Co., Inc.* **E-309**

Automatic Taper

According to the manufacturer, the L-P automatic taper can easily be integrated with all existing or new pallet loading systems, both automatic or manual. The unit automatically applies a strip of pres-



sure-sensitive tape, in any width from ¼ to 1½ inches to the top layer of a unit load, with or without pallet, in just eight seconds, the manufacturer claims. Positive taping is said to be assured by a mechanical spring-loaded follower roller which applies consistent pressure to the tape, against the cartons, as it circles the load. The tape is then overlapped, cut, and clamped automatically at the end of the cycle. The taping arm is powered by a ¼ hp brake motor and the tape overlapping and cutting actuated by air. The L-P Taper is adjustable for various size loads and for many types of containers, including cartons, cases, cans, etc. The load capacity range is 40 to 54 inches long, 34 to 48 inches wide, and 28 to 72 inches high. *Lathrop-Paulson Co.* **E-310**

Fluorometer Model 110

This general-purpose analytical tool, useful in measuring casein glue through packaging materials, and applicable to studies of catalyst setting plastics, and migration of plasticisers, is particularly suited to the measurement of very small amounts of material. The instrument is basically an optical bridge, (analogous to the Wheatstone Bridge used in measuring electrical resistance), which measures the difference between light emitted from the sample and that from a calibrated rear light path. *G. K. Turner Associates.* **E-311**

Arc Imaging Furnace

This unit provides a non-contaminating heat source for a variety of laboratory uses in the 2500° to 4000°K. region. It combines a high intensity blown arc with an optical system for re-imaging the radiant energy onto a sample. In principle, an arc is struck between two carbons, and the tail flame plasma concentrated by a ring of impinging air jets. Both electrodes are water and air-cooled, permitting higher current dinsities, according to the manufacturer, than can be used with conventional carbon arcs. The plasma is rotated by a magnetic field surrounding the positive-carbon. The result is a relatively symmetrical heat source of great intensity with an easily operated stable arc. The radiant energy of this heat source is first collected on an ellipsoidal projection mirror and then re-imaged by a similar mirror. The sample is positioned on the focal axis so that the desired temperature and irradiance levels may be achieved. The system can also be operated with the axis of the re-imaging mirror in either the horizontal or the vertical position, permitting both the use of the sample as its own crucible and the study of liquids. *Arthur D. Little, Inc.*

E-312

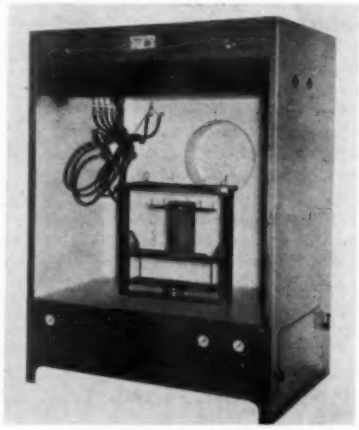
Temperature Detector

A miniature tip-sensitive temperature detector is available which can be mounted in the bearings of machinery. Only ¼ inch long by 0.278 inches in diameter, the detector, Model 327, has a resistance temperature detector so small that it can also be used in many places where larger temperature measuring instruments would not fit. The sensing element or winding of the detector is located the first .060" of the tip, allowing for fast response to temperature changes. The shell of the detector is made of brass and the tip is "tinned" so that it can easily be soldered to the metal surface to be measured, or be covered with babbitt if used in a bearing. It can also be connected to indicators, recorders, or controllers by means of ordinary copper wire. *Thomas A. Edison Industries.*

E-313

Tilting Spray Machine

An automatic spray machine has been developed which coats one, two or three surfaces of generally oval or rectangular-shaped pieces of varying length. Designated Model SVF, it is designed for use where



fine mask definition and coat demarcation are imperative. The length and speed of the coating stroke are adjustable within the limits of the size of the model selected. The machine features a device which embodies a fore-shortened pivoting action, and permits tilting of the overhead traveling guns in one or two directions to permit coating both directions when the part is in position.

It is claimed that coverage is assured under all mask bridging, and hard-to-reach recessions, corners, and edges of the part, with a reduction in overtravel and a saving of coating material. Another advantage, according to the manufacturer, is that the tilting mechanism permits the designing of machines of reduced length. The guns can be set so as to remain motionless. Entirely air-operated, Model SVF is housed in its own booth, which can be connected with the existing exhaust systems. If necessary, fan and motor can be supplied as an extra. Air filtering, cylinder and air valve lubrication and water trap ejector are all automatic. *Conforming Matrix Corp.*

E-314

FOR MORE INFORMATION on these new products use the Readers Service Coupon in this issue.

Lightweight Masker

A lightweight unit, Permacel 10A Bench or Wall Mount Masker can be used in auto repainting and commercial masking operations in spray and roller painting work and plastering. The masker has a steel frame and a serrated cutter of specially treated steel. It can accommodate a single 39-inch roll of masking paper or any combination of rolls through 36 inches. Equipped with suction grips for secure anchorage, the masker can be bench or wall mounted and is also designed to be carried easily from job to job. The addition of a 101 Masker Conversion Kit will enable the used to dispense a double taped apron or two rolls of masking paper from one machine. *Permacel.* **E-315**

Adhesives Pump

Designed for pumping adhesives as well as abrasive or corrosive liquids or slurries at moderate pressures, this new line of pumps are of the diaphragm type, said to have the advantage of built-in pressure regulation. According to the manufacturer, the key feature of the pump is that the liquid being pumped is completely isolated and sealed off and never comes into contact with the mechanical parts of the pump. The pump has a short stroke (3/16-inch) and develops zero to 6 gpm at 100 psi at zero to 600 rpm, or 6 to 12 gpm at 60 psi at 600 to 1200 rpm. *Hydro-Dynamics Research Industries.*

E-316

Temperature Test Chamber

The new Hi-Lo Temperature Test Chamber, Model 1523, has a temperature range of −100° to +400° F., ±1°F. Claimed to be ideal for stability and thermal shock studies, the unit is capable of dropping to −100°F. in minutes. The coolant is liquid CO_2, dispersed uniformally by dual high velocity blowers. The cabinet is constructed of heavy gauge, cold rolled steel which has been treated against rust and finished in baked enamel. The interior, measuring 53 x 30 x 30 inches, is stainless steel. *Electric Hotpack Co., Inc.*

E-317

book reviews

Viscoelastic Properties of Polymers. ***By John D. Ferry. Published by John Wiley and Sons, Inc., 440 Park Ave., S., New York 16, N.Y. 6¼ x 9¼ in. 482 pp.*** **$15.00.**

During the past two decades viscoelasticity of polymers has been the subject of a great deal of chemical and physical research. Reports of this work as published in dozens of journals have pinpointed the progress being made in many specific areas of rubber, plastics and fibers. The search has been for a more complete understanding of the mechanical behavior of these materials in processing and in the end product.

In this volume, the author, Professor of Chemistry and Head of the Department, University of Wisconsin, has synthesized many of these separate studies. In attempting a summary of specific findings and theory to date, his premise is that conceptual schemes in the field have now reached a level of maturity where this can be done with a number of benefits accruing.

He has, for instance, been able to suggest areas where further theoretical and experimental advances are required, and to provide working information assembled from numerous sources for measuring and interpreting data. As a basic text, the volume is designed also to introduce to investigators newly exposed to polymer viscosity in industrial laboratories the basic concepts of the field. By the use of several examples it also outlines possible techniques by which practical problems in analysis, processing and use of polymers can be attacked.

The author, in initial chapters, has chosen to develop the subject of viscoelasticity by the use of both formulas and (mechanical) models. While the book is highly theoretical, the latter reoccur throughout, supplying a graphic picture of the particular stress-strain relationship under study. In the author's words, "The experimental problem in any study of viscoelastic behavior is to determine the relations among stress, strain, and time for a particular type of deformation, and a particular loading pattern, i.e., stress history."

For professionals in the field who are involved with such problems, this volume should be something of a handbook. The treatment of type, illustrations, and formulas is in particularly good taste, simplifying the intricate subdivisions into which the text material is divided.

Chapters on nature of viscoelastic behavior, and illustrations of this, are followed by an exploration of the interrelations of viscoelastic functions. Experimental methods for determining these functions are then explored through a series of five chapters; subsequent topics include molecular theory, the effects of temperature; concentrated solutions and plasticized polymers; gels and cross-linked solutions; behavior in bulk deformation; and illustrative applied calculations.

Of the applied calculations discussed, one has to do with estimate of heat production in cyclic deformation, as in automobile tires, and a second on vibration damping by use of polymeric material in a thin covering layer.

Source Book of the New Plastics: Volume II. ***Edited by Herbert R. Simonds. Published by Reinhold Publishing Corp., 430 Park Ave., New York 22, N.Y. 6 x 9 in. 310 pp. $8.95.***

This second volume in a series on current developments in plastics covers the period from 1959 through mid-1960. Like its predecessor (reviewed in ADHESIVES AGE, Vol. II, No. 12, p. 62) this book is primarily about materials, though several new features have been included: a chapter on progress in technology, and one on new processes and applications. During the period covered by this book, according to the editor, emphasis in the industry has been on new additives, extenders, and modifications of existing polymers, with previously introduced primary materials being developed commercially.

The major portion of the book is devoted to statements by producers and suppliers about their new developments. A concluding chapter surveys plastics research sponsored by the Federal Government since 1959. Prepared by James Kanegis of the Department of Commerce, this report is described as the only available survey of government sponsored research in plastics.

In it, research by the Air Force in inorganic polymers, which may eventually lead to commercially feasible structural adhesives is referred to. Also noted are a series of studies at Picatinny Arsenal on epoxy-base, and solventless-base self-catalyzed adhesives; high temperature adhesives research; and a polyurethane foam mixture used to bond fractured bones until they knit.

The worth of a volume such as this is in its ability to provide up-to-date information about new developments. In achieving this timeliness, the editor and his Advisory Group have relied on statements by 69 contributing firms. Inevitably, their reports vary in clarity and scope. As indicated in the preface, of the 60 plastics suppliers represented in the first volume, 35 have reported their subsequent advances for Volume II. The remaining 34 entries are new. For those particularly interested in adhesives, the index is relatively incomplete; and the reference to page 292 there should be 293.

Trade Literature

COATINGS CONSULTANT. This eight-page folder tells how the independent consultant in the coatings field assists both manufacturers and users of coatings with their research and development problems. With emphasis on the consultant's role, the brochure discusses formulation, testing, and other coatings research such as biological and toxicological problems. *Foster D. Snell, Inc.* **L-360**

PLASTIC DISPENSER. Twenty-one new dispensers for epoxy and polyester resins are described in this new illustrated pamphlet. The dispensers are designed for 2, 3, or 4 component materials, in high and low viscosity formulations. In addition, the pamphlet describes manual, electrical, and fully automatic dispensing operations for potting, tooling, pattern making, and production molding of reinforced plastics. *United States Gypsum Co.* **L-361**

MICARTA GLASS POLYESTERS. This eight-page brochure is a selection guide for glass polyesters — water-resistant glass-mat laminates and molding compounds for Class B insulation application. The brochure emphasizes features of low water absorption, lightweight, economy, flame retardance, and arc and track resistance for reliability in contaminated atmospheres. Physical and electrical properties of 10 grades of glass-mat laminates and of three grades of glass molding compounds, with low, medium, and high impact qualities are given. *Micarta Division, Westinghouse Electric Corporation.* **L-362**

ROTARY SPRAYING MACHINE. This two-page leaflet describes an air-operated, automatic, single spindle, rotary spraying machine with vertical traveling guns. The machine is designed for finishing cylindrical and rectangular parts. It is called Model SS2GVT, and is also available with mask washer and spray booth as Model SS2GWB. Photographs of the two models are included in the publication. *Conforming Matrix Corp.* **L-363**

HIGH TEMPERATURE EPOXY ADHESIVE. Hysol 4322 epoxy adhesive is described in this two-page bulletin. The adhesive is reported to have a tensile shear of 2200 psi at 500°F. on aluminum-to-aluminum. In addition, the smooth, thixotropic, 100 per cent solids paste

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by: S. Buchan

M.A., B.Sc. (Aber.), Ph.D. (Cantab),

F.R.I.C., A.I.R.I.

1959, 296 pages, with bibliography

$7.50

This new edition of Dr. Buchan's important and comprehensive work, has been completely revised and up-dated to include the many advances and new developments in the technology of bonding rubber-to-metal in the 10 years since the publication, in 1948, of the widely-acclaimed original edition. Describes processes, applications and methods in detail. Gives concise, straight-forward explanations of how to handle rubber-to-metal bonds at each stage of the job. Sufficient materials are included with each description to permit the reader to project given examples to his own needs. Written by the chief chemist of one of the most successful bonding firms in the world, this is the single most complete source of information about a subject of major technical importance to men working in the rubber adhesive industries.

CONTENTS:

Introduction
Plating Plant
Cleaning Solutions
Brass-Plating Solutions
Methods of Analyses
Electro-Plating
Processing and Process Control
Natural Rubber Compounding
Synthetic Rubber Compounding
Molds and Molding (38)
Physical Examination of Brass Deposits
Chemical Examination of the Rubber-to-Brass Bond
Properties of the Rubber-to-Brass Bond
Bonding Agents, Thermoplastic
Bonding Agents, Halogenated Rubber Derivatives
Bonding Agents, Polyisocyanates
Bonding Agents, Various
Bonding Vulcanized Rubbers
Testing Bonded Units
The Nature of the Rubber-to-Metal Bond
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Trade Literature (Cont'd.)

reportedly will not flow during cure, even when applied to vertical surfaces, and is said to be ideally suited for bonding porous surfaces. It is also recommended for bonding metal, plastics, ceramics, glass, and wood. A slight resiliency insuring against cracking during thermal shock, and a 14-month shelf life at room temperature are other advantages cited. *Hysol Corp.* **L-364**

PROPERTIES AND USES OF THF. A compilation of physical property data on tetrahydrofuran (THF) as well as information on its use and handling are included in this 16-page booklet. The literature covers the uses of THF as a resin solvent in adhesives, protective coatings, topcoating, film casting, and printing inks. Its other uses are as a solvent in chemical operations and as a chemical intermediate. *Electrochemicals Department, E. I. du Pont de Nemours and Company.* **L-365**

SPRAY MACHINE. Brochure ET-400 contains information on an air-operated, reciprocating type spray machine for spraying areas of the smallest products up to 12 inches wide and 40 inches long. *Conforming Matrix Corp.* **L-366**

CELLULOSE GUM. A new, revised edition, this 36-page illustrated book gives a review on what Hercules cellulose gum is and where and how it is used. It is pointed out that cellulose gum is used in adhesives such as in leather-pasting operations where its ready water solubility allows quick removal. In addition, cellulose gum is sometimes used to control and stabilize viscosity in corrugating and laminating adhesives. *Hercules Powder Co.* **L-367**

MIXERS. A line of mixers for dispersing, emulsifying, and milling in one operation are described in this 12-page catalog. Called the Dispersall Mixer, the line is said to be applicable to all kinds of fluid mixes from thin slurries to pastes. Specifications and performance data are included. *Abbe Engineering Co.* **L-368**

CAULKING GUNS. New and improved caulking guns are described in this four-page, two-color catalog. The catalog is illustrated and contains details on the capabilities, dimensions, and construction of a number of models of caulking guns. *Vital Products Mfg. Co.* **L-369**

MICRO-INDENTATION TESTER. Measurement of the hardness of surface coatings with the Wallace electronic micro-indentation tester is described and illustrated in this six-page folder. The literature reveals that the most reliable method of measurement of the hardness of surface coatings is by penetration into the coating perpendicularly to its surface. The resistance which is offered to the penetration can be considered to be a definition of the hardness of the coating material. Discussed are the principle of the instrument, its construction, mounting the specimen, and application. *Testing Machines, Inc.* **L-370**

FIBER-BACKED ABRASIVE DISC. A four-page illustrated publication, this booklet describes a sanding disc for lighter grinding operations, where little or no dressing action is involved. The booklet discusses the various uses for the manufacturer's line of sander discs and contains a chart showing performance factors. *The Carborundum Co.* **L-371**

FOR MORE INFORMATION on the literature items described here, use the Reader's Service Coupon in this issue.

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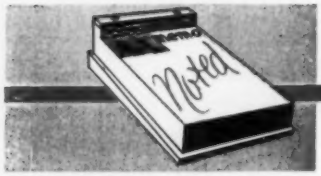
ADVERTISERS' INDEX

MAY, 1961

Adhaesion	64
Adhesives Guide	11
Air Reduction Chemical & Carbide Co.	3
Black Brothers Co., Inc.	55
Darling & Co., Glue Div.	5
Dural Co., Inc.	8
Hercules Powder Co.	Cover 4
Leffingwell Chemical Co.	4
Narmco Industries Inc.	53
Neville Chemical Co.	Cover 3
Potdevin Machine Co.	8
Reichhold Chemicals Inc.	9
Ross, Charles & Son	49
Rubber to Metal Bonding	63
Schenectady Varnish Co., Inc.	Cover 2
Shawinigan Resins Corp.	6
Velsicol Chemical Corp.	13



in passing

Better Business

Use of phony advertising and selling practices to meet competition during the current recession may well invite government to place new restrictions on business, according to Victor H. Nyborg, president of the Association of Better Business Bureaus, Inc. In a warning to advertisers, Mr. Nyborg said "government will not stand idly by if business fails to heed past warnings of government and industry leaders to clean up voluntarily or face the consequences." Mr. Nyborg noted that hard times make for stiff competition and that this leads to corner-cutting and truth-stretching. He said there is a threat that sharp practices will arise which will harm the promising surge of self-policing being promoted by many business organizations.

"Any relaxation by business, using the recession as an excuse, will only be another invitation for the people's elected representatives—always sympathetic to their problems—and attentive agencies to further regulate the marketplace", he warned. Mr. Nyborg added that the "threat is still very real, although subdued at the moment". Urging business to "tighten its ethics belt and make self-regulation meaningful," Mr. Nyborg said "business must work its way out of the recession in a way which will assure public confidence and renewed strength for our economy."

Idea to End Product

For every 540 new ideas originating in research laboratories, one finally results in a useful product, according to research scientists for Goodyear Tire & Rubber Co. In 1954, seven years were required to move an idea from its birth through the many steps necessary to turn it into an end product. This "test-tube-to-tank-car" transition now requires only five years, the company reports, as a result of increasing new emphasis on research and development activity.

Sole-Searing Idea

Boot and Shoe Recorder reports that a London physician has advised motorists who are afraid of falling asleep at the wheel to take off their shoes and socks. In a letter to the *British Medical Journal*, the good doctor declares that driving with bare feet is a good remedy for pulling out of a snooze. A talky wife will probably do the job as well, we say.

Now Hear This

The publication "By Gum" (Reichhold Chemicals) reports that an expectant mother said to her little boy: "Now, Ronnie, if you pray real hard, maybe the Lord will send you a little sister." The following night, after he had said the usual short prayer, his mother heard him add: "Dear Lord, if you have a baby sister almost finished, don't bother to put her tonsils in as they will just have to be taken out anyway."

"By Gum" also tells the one about the British naval lieutenant commanding his first ship—a frigate—during recent NATO maneuvers. He bumped into another vessel causing only slight damage but considerable confusion in the deployment of the fleet. The admiral commanding the operation signaled: "What do you propose to do now?" The lieutenant's answering signal, seen by the whole fleet, was: "Buy a small farm, sir."

Movies and Bulls

The publication "NADA" notes that a discussion about whether cows might enjoy movies or not has been greeted with a chorus of moos. An extension service dairyman for the University of Maine wondered if the animals would be more content during the winter months they must spend in the barn if movies were shown to them. A group of farmers cooperated in the experiment and recorded the surprising reaction. *The cows mooed at the sight of alfalfa and mooed even louder when bulls appeared on the film.* No interpretation of this reaction was offered.

Statistics

Coal haulers delivering 14 tons of coal to a downtown Chicago building recently found a square hole that looked like a sewer and a round hole that looked like a coal chute. So they poured the coal in the round hole. But the square hole was the coal chute and the round hole was a sewer. When water began backing up in the building, a spokesman for the coal company hastened to explain that it was all a mistake. "After all," he said, "the odds were 50-50."

Think Small!

One little boy to another: "My dad's car is smaller than your dad's car."